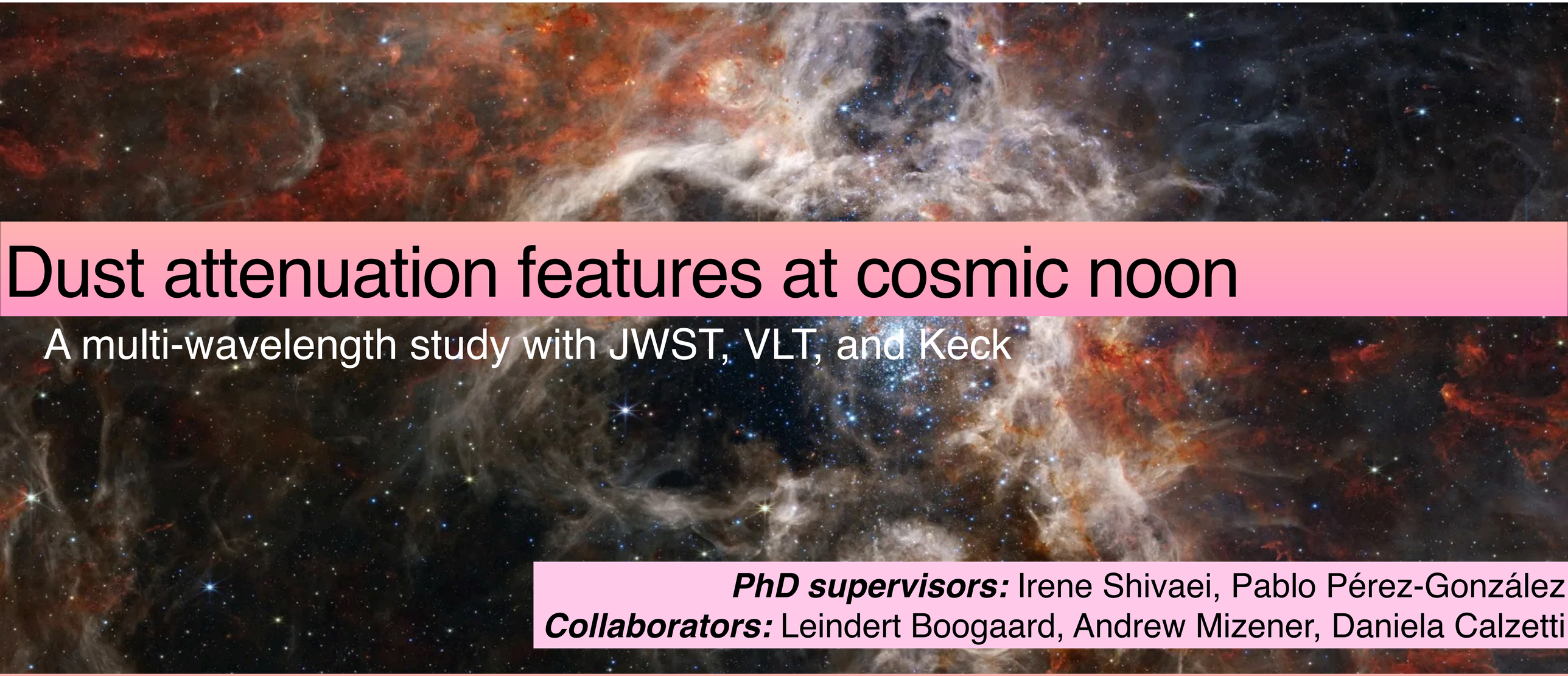


# Dust attenuation features at cosmic noon

## A multi-wavelength study with JWST, VLT, and Keck

***PhD supervisors:*** Irene Shivaei, Pablo Pérez-González
***Collaborators:*** Leindert Boogaard, Andrew Mizener, Daniela Calzetti

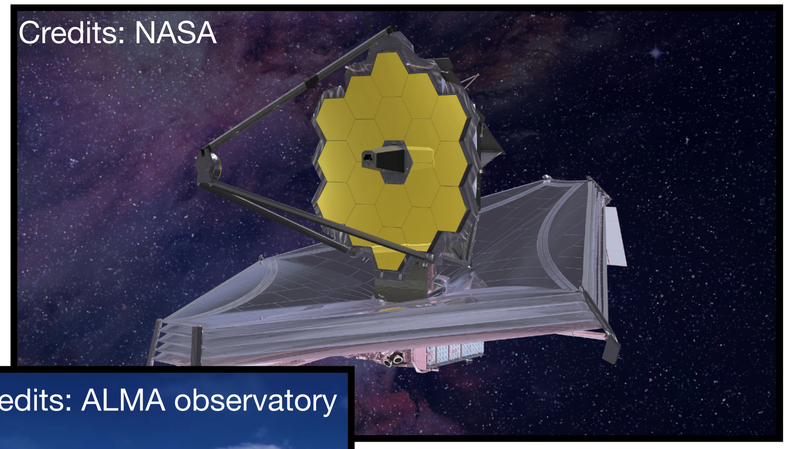
# Galaxy Evolution Group (Centro de Astrobiología)



Check our website!

# Galaxy Evolution Group (Centro de Astrobiología)





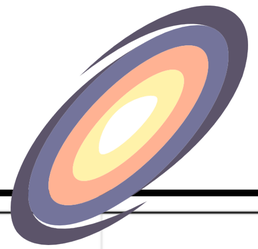




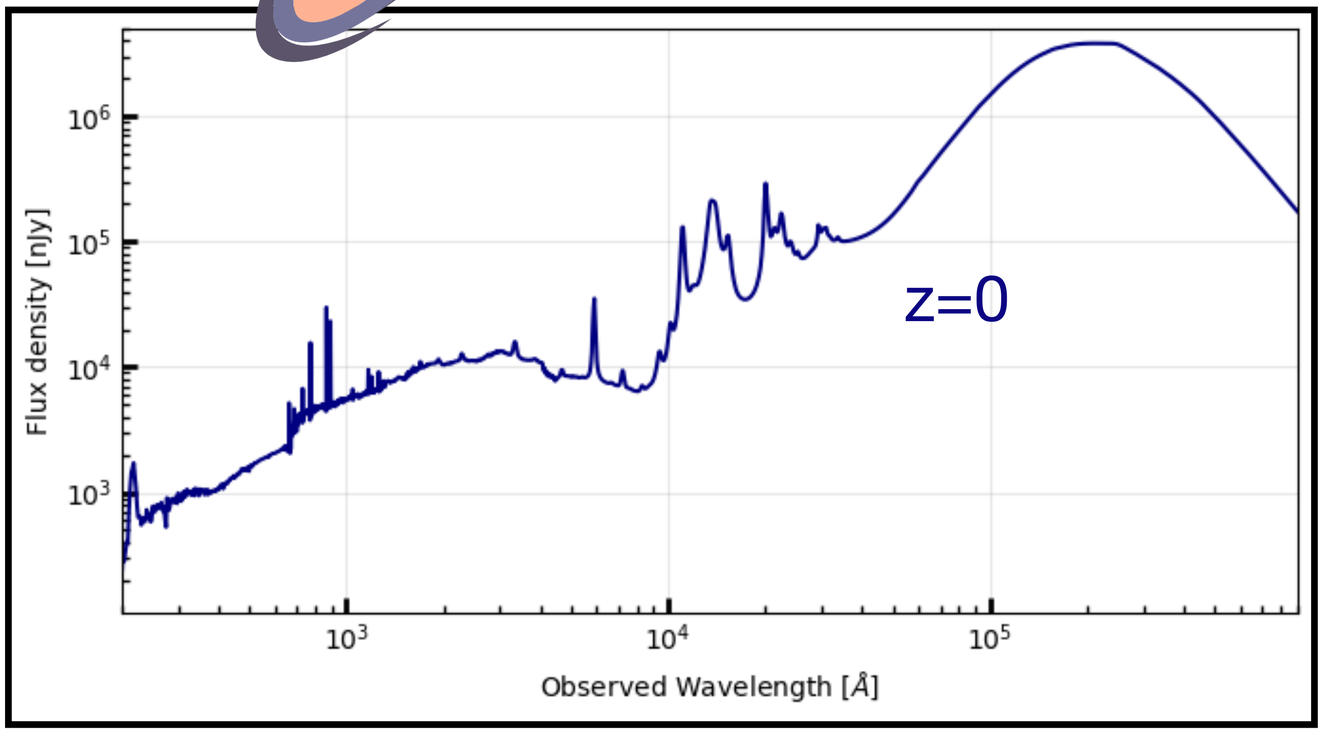
High redshift galaxies (mostly)

Check our website!

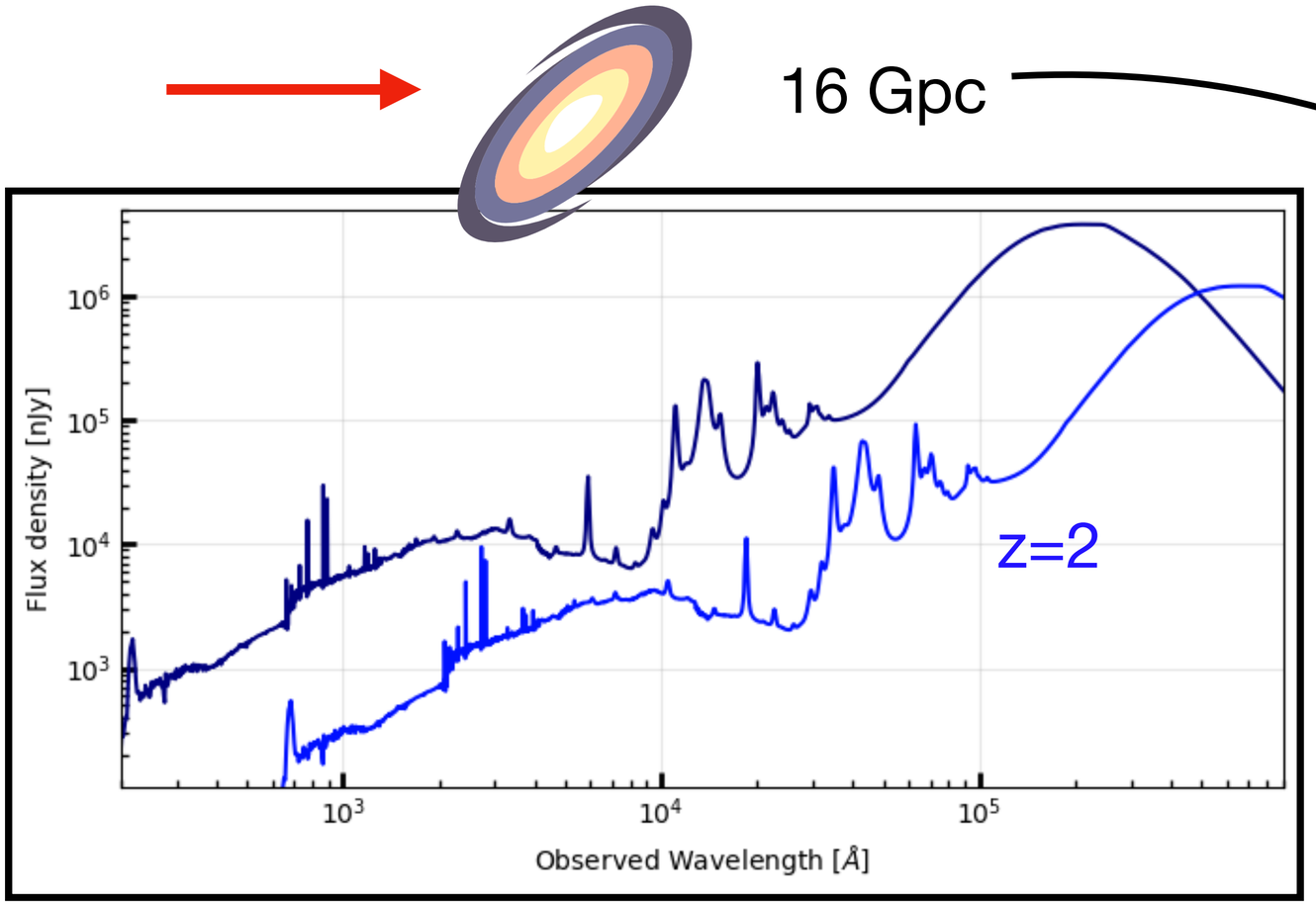
# Cosmological redshift (z)



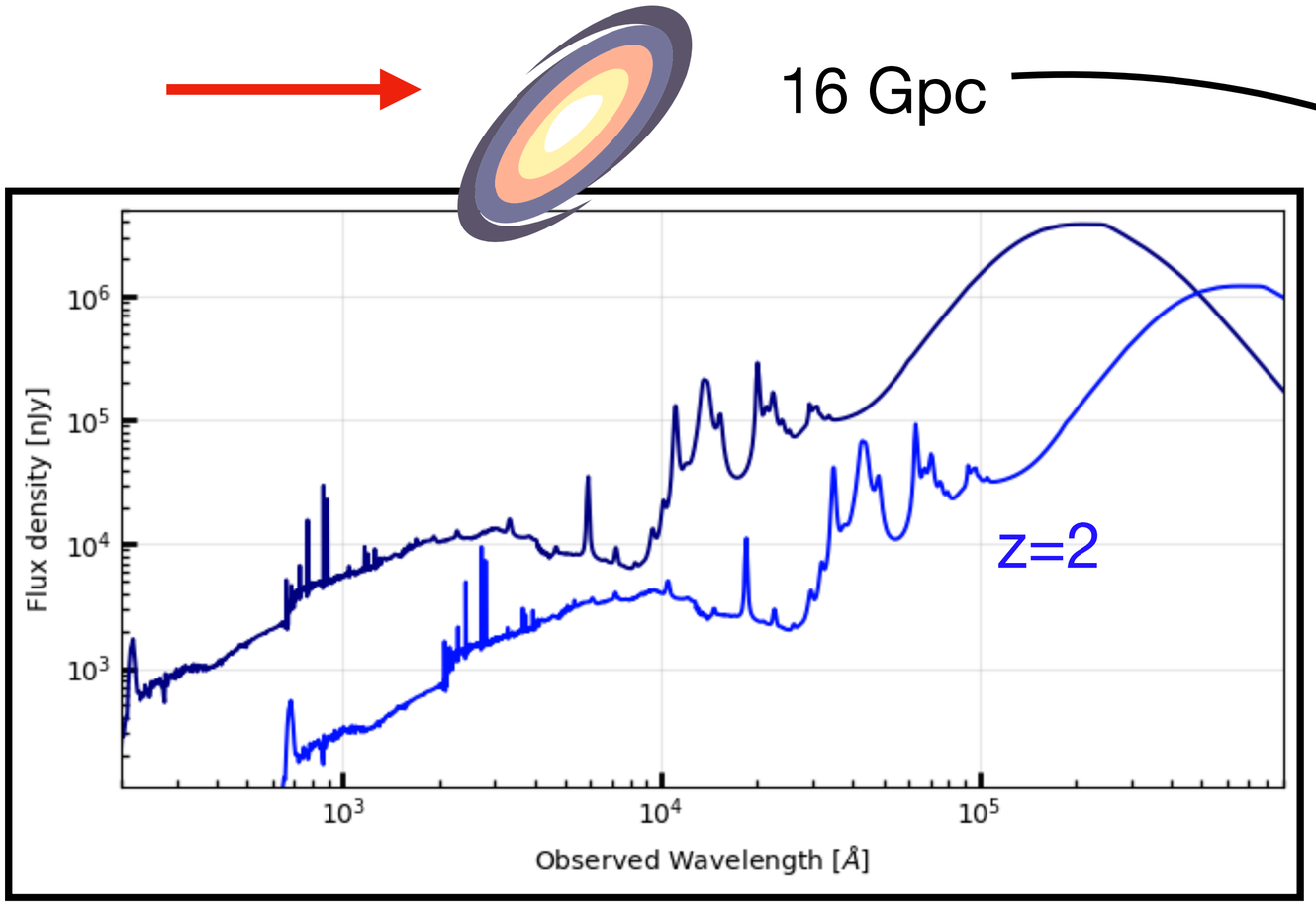
Here (and now)



# Cosmological redshift (z)



# Cosmological redshift (z)

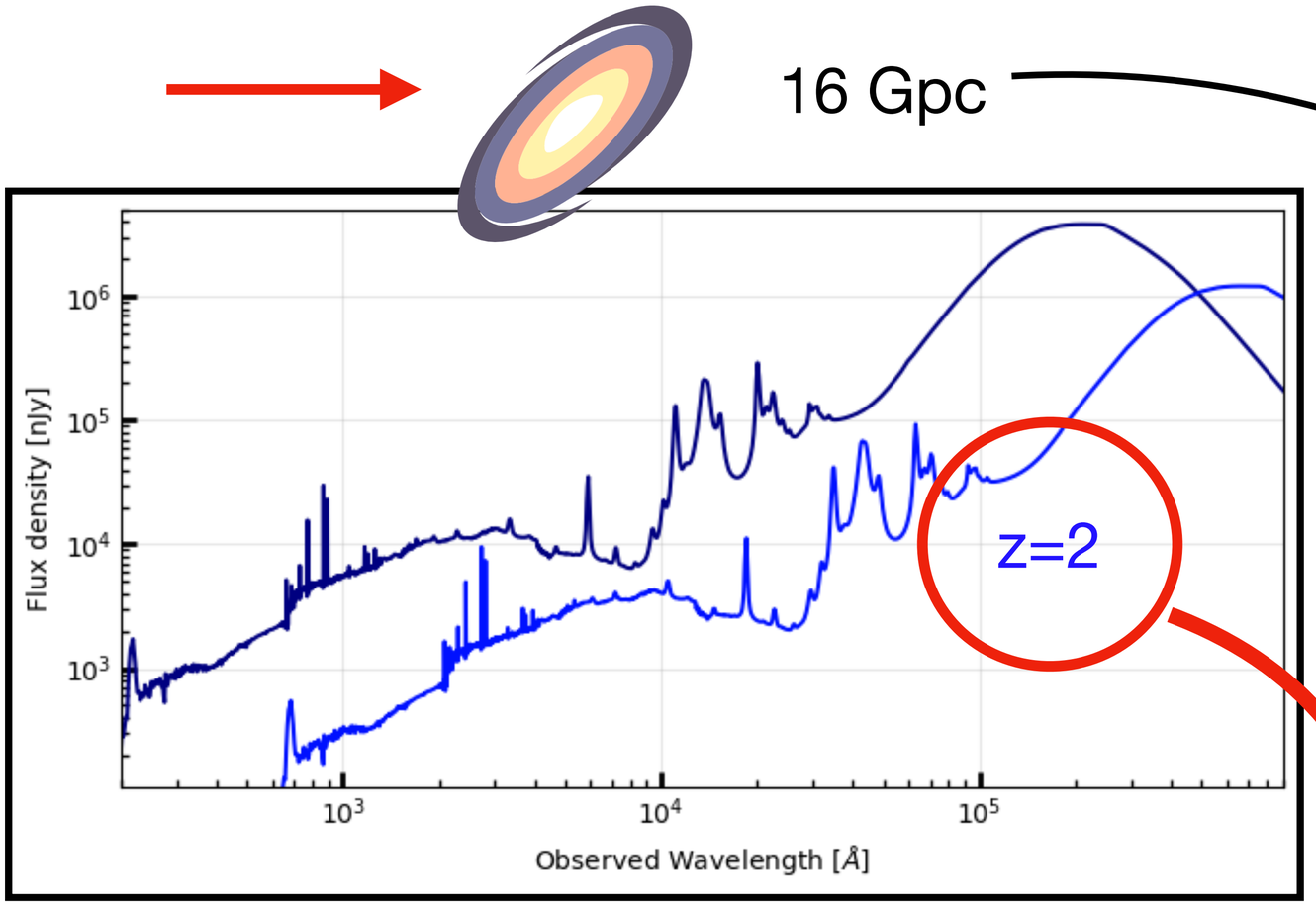



$\sim 52 \times 10^9$ ly

$\sim 5 \times 10^{23}$ km

10.4 Gyr “away” from us!

# Cosmological redshift (z)




16 Gpc

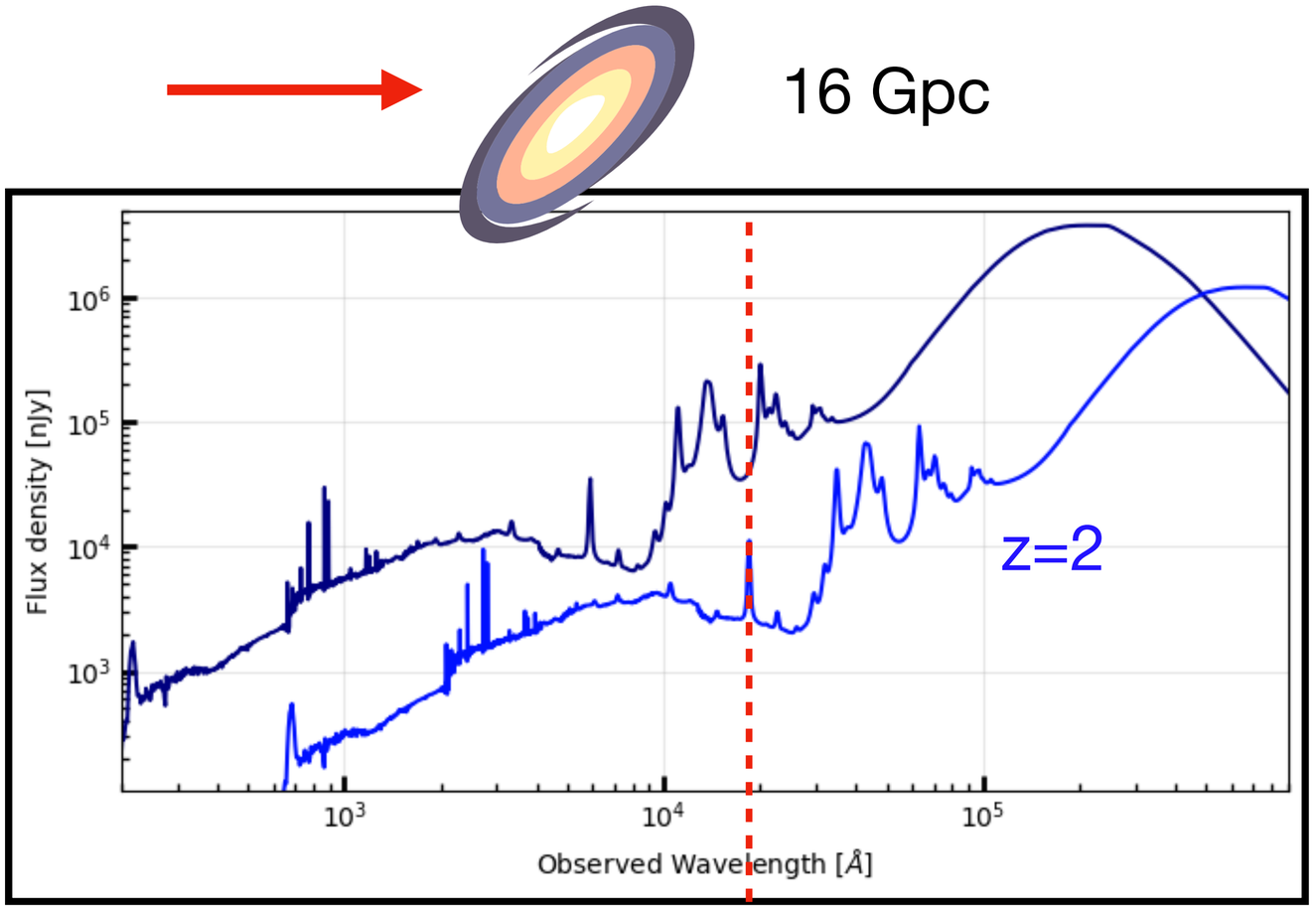
$\sim 52 \times 10^9$ ly

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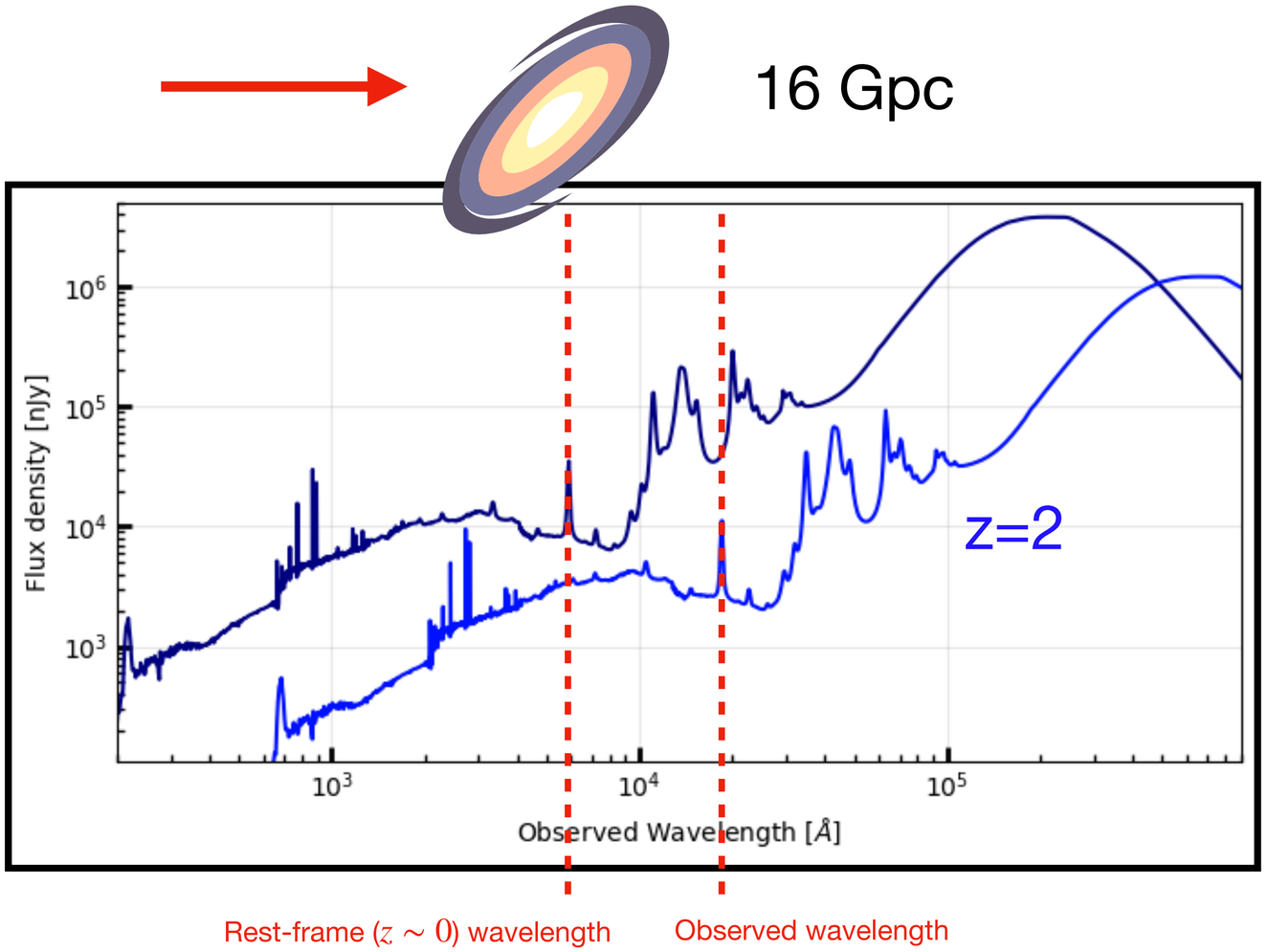
10.4 Gyr “away” from us!

Cosmic Noon

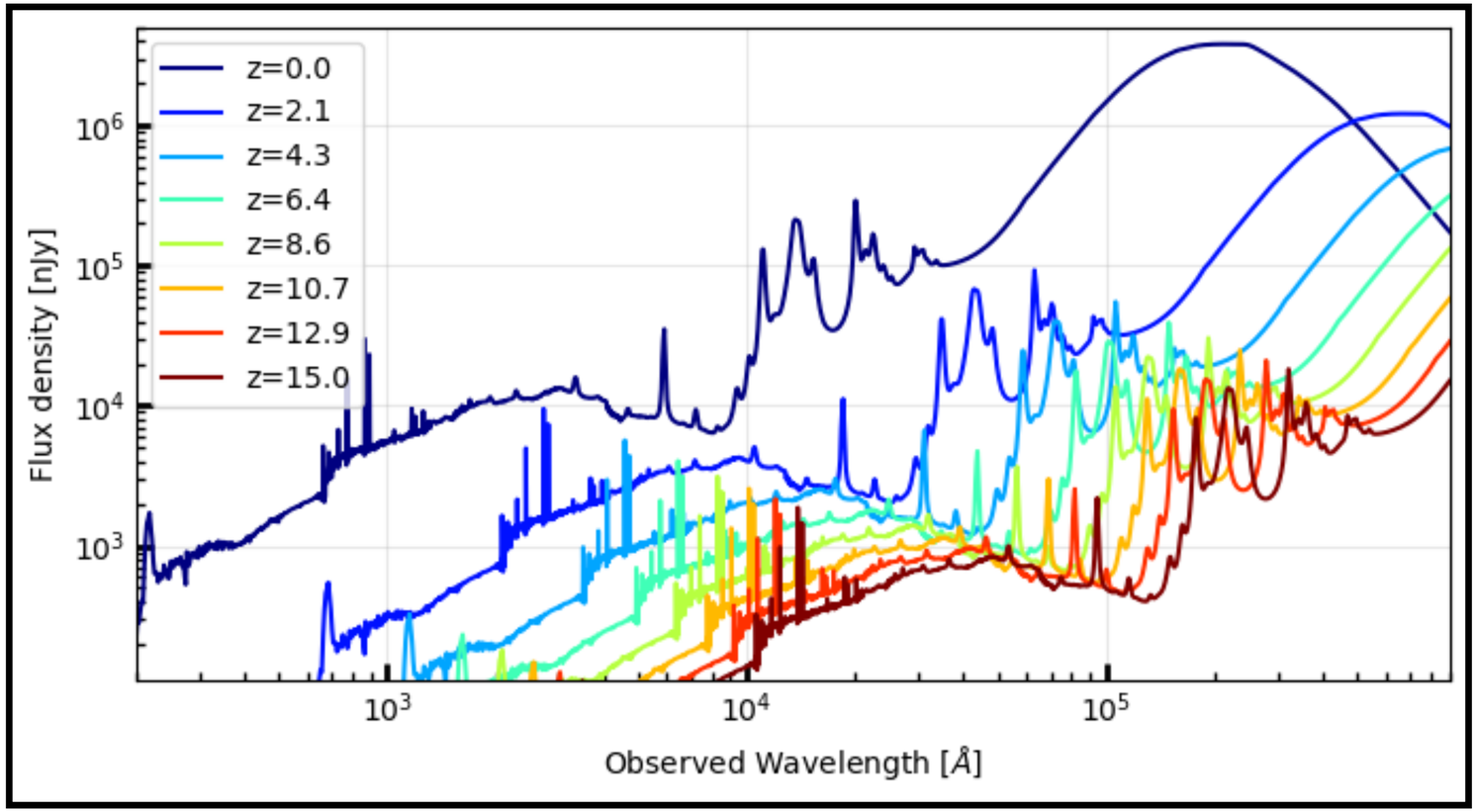
# Cosmological redshift (z)



# Cosmological redshift (z)



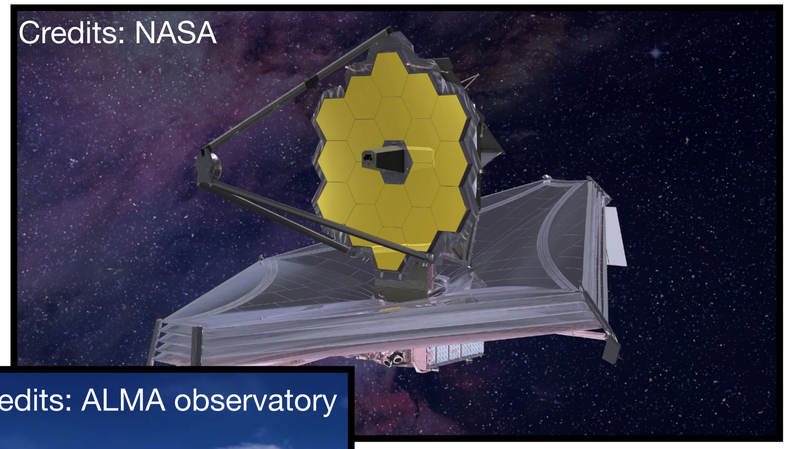
# Cosmological redshift (z)




$$1 + z = \frac{\lambda_{\mathrm{obs}}}{\lambda_{\mathrm{rf}}}$$

# Galaxy Evolution Group (Centro de Astrobiología)







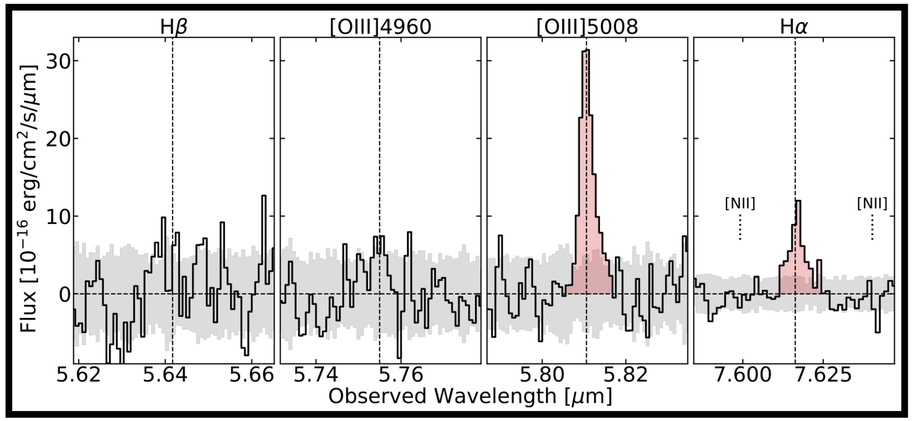


High redshift galaxies (mostly)

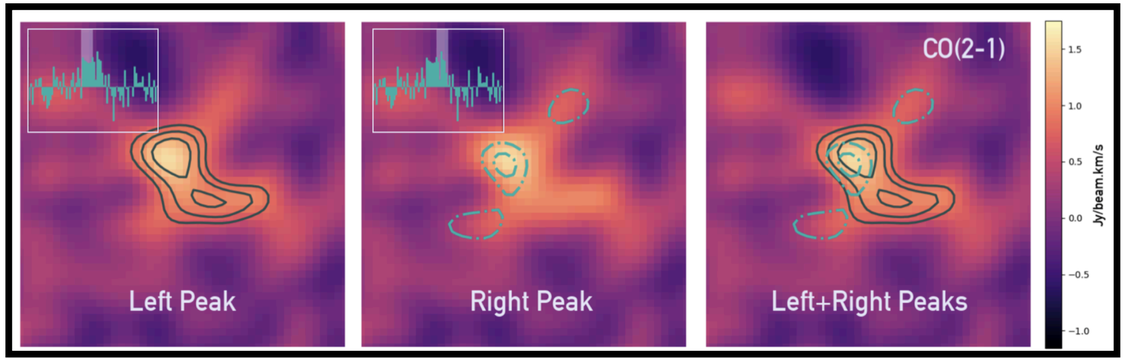
Check our website!

# Galaxy Evolution Group (Centro de Astrobiología)






$z \sim 11$ galaxy with JWST/MIRI (Álvarez-Márquez+25)




Dust-obscured merger @ $z = 1.17$ with ALMA (Langan+24)

Check our website!

Leonor Arriscado - larriscado@cab.inta-csic.es

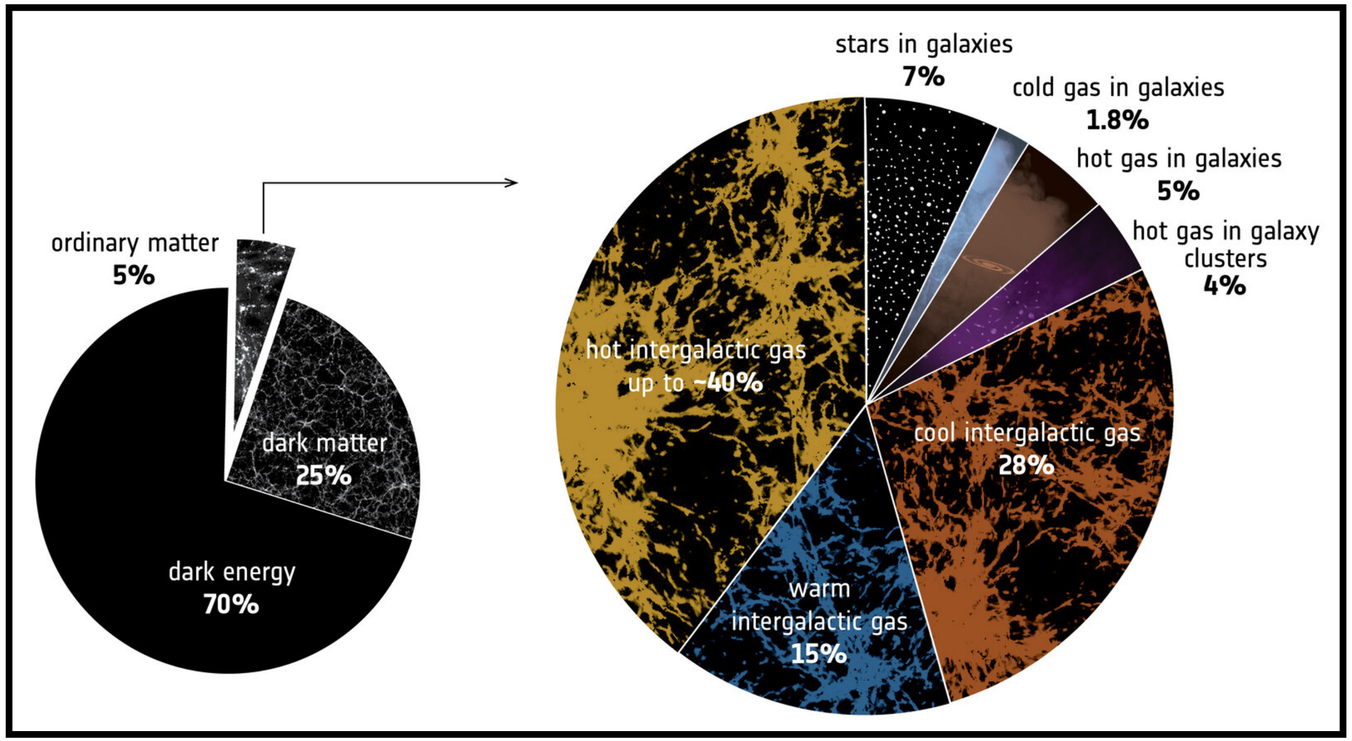
# The role of dust in galaxies




Check our webpage:

# The role of dust in galaxies

Dust: $\sim 0.02\%$ of baryonic mass in galaxies

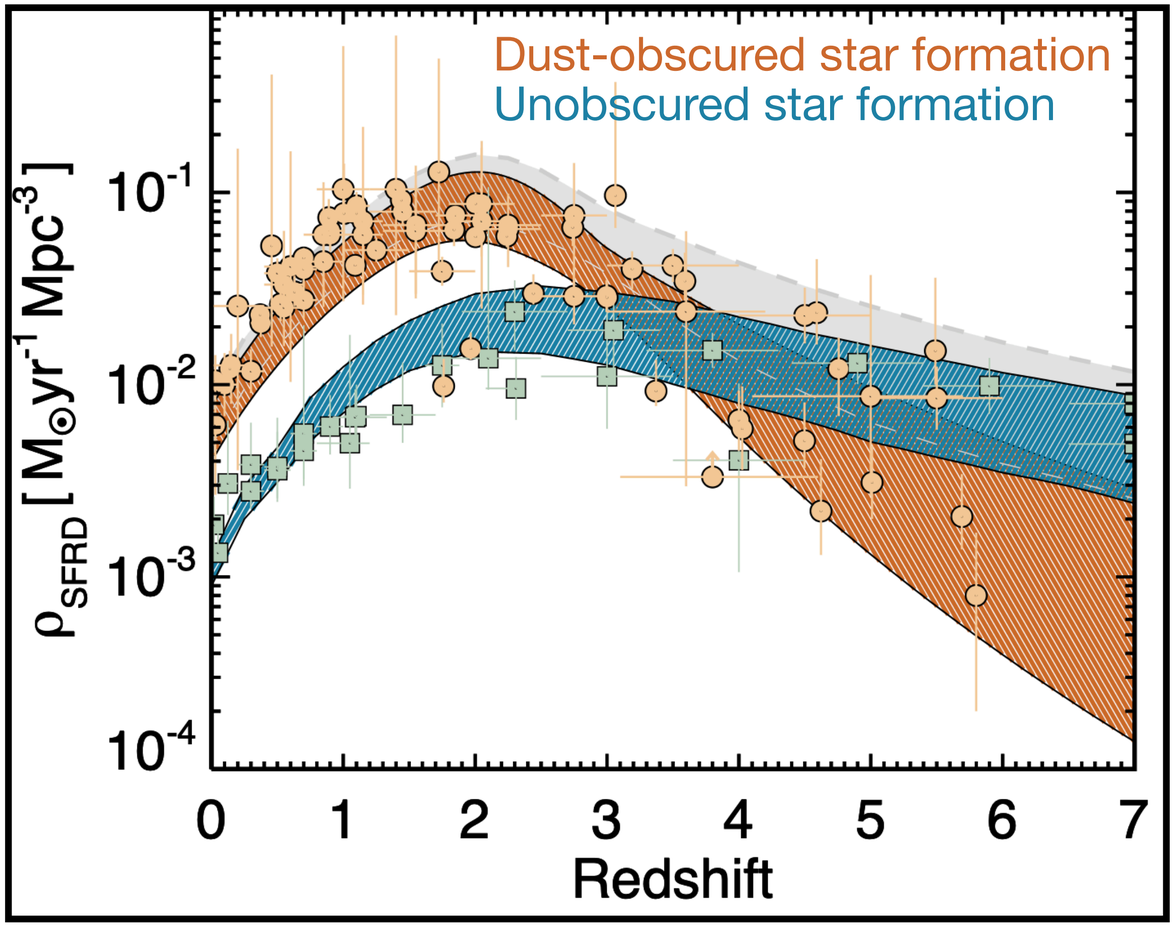



DistantDust

Check our webpage:

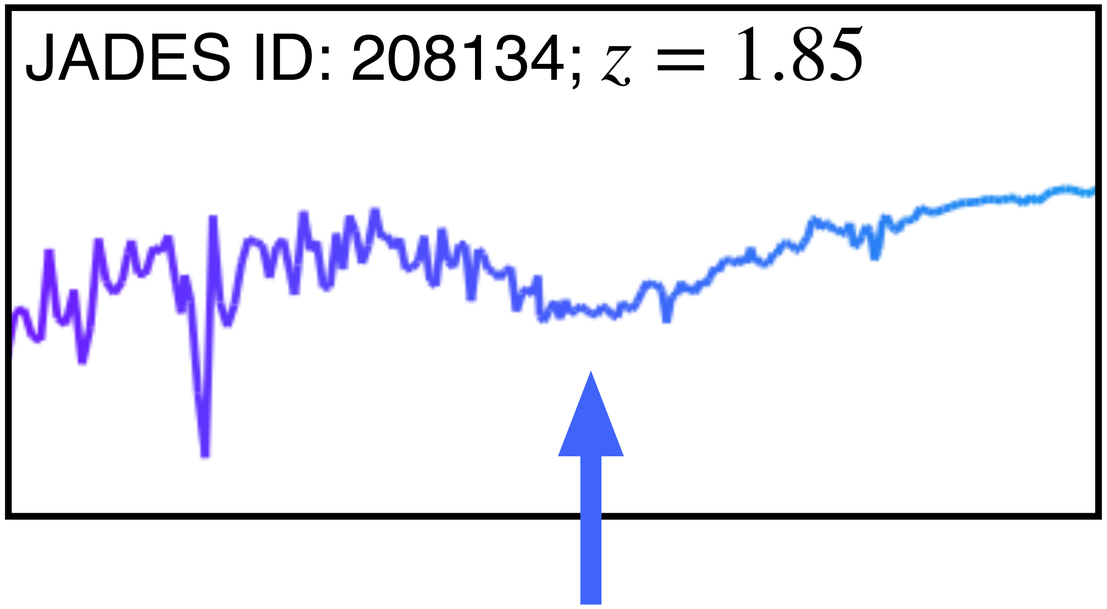
Leonor Arriscado - larriscado@cab.inta-csic.es

# The role of dust in galaxies

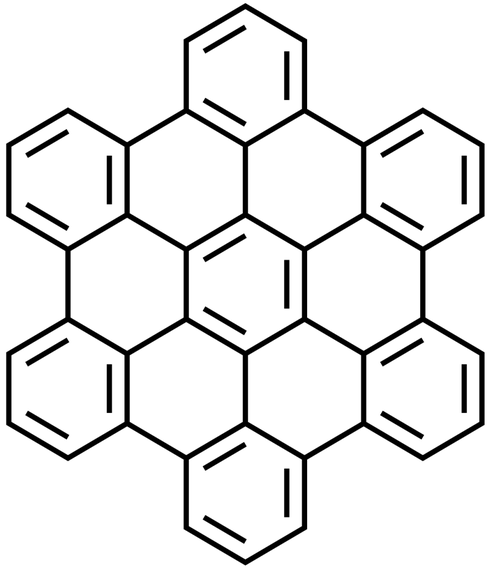



Zavala+21

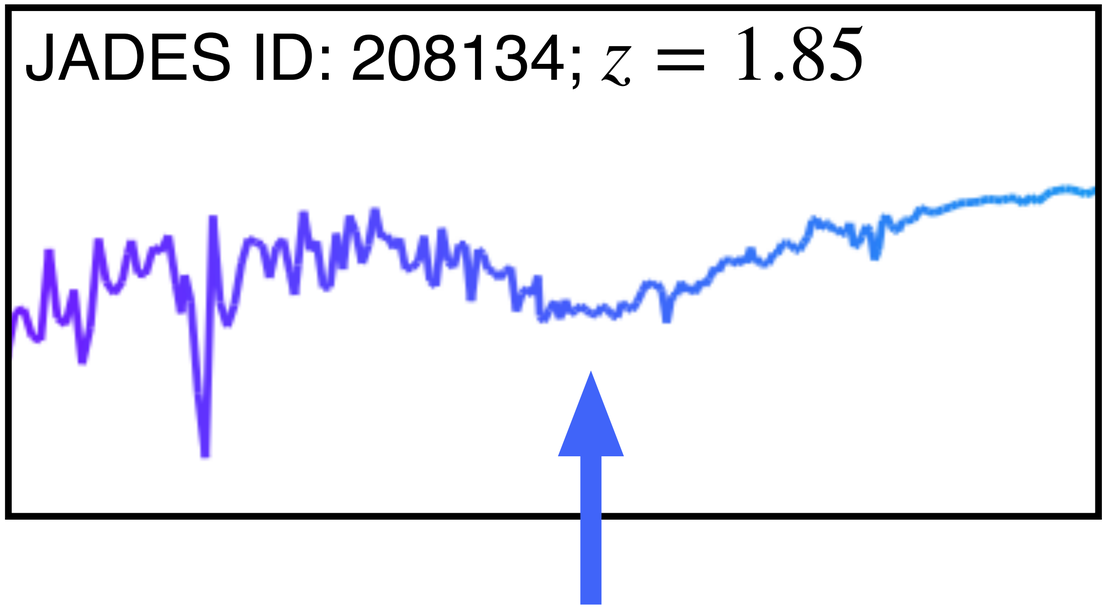
# The UV 2175Å attenuation bump



# The UV 2175Å attenuation bump and PAH emission

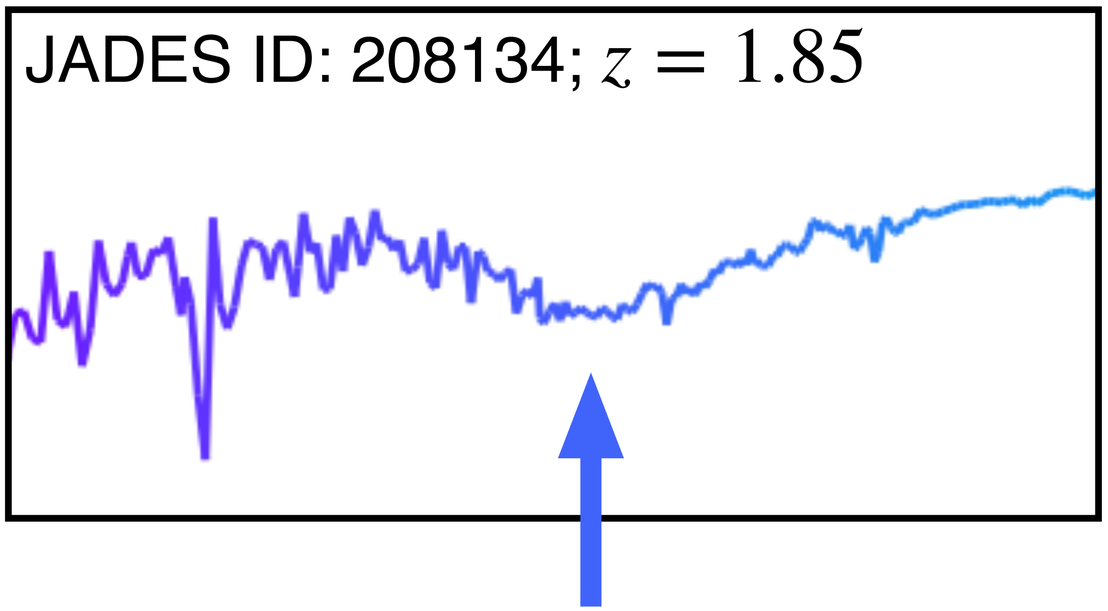


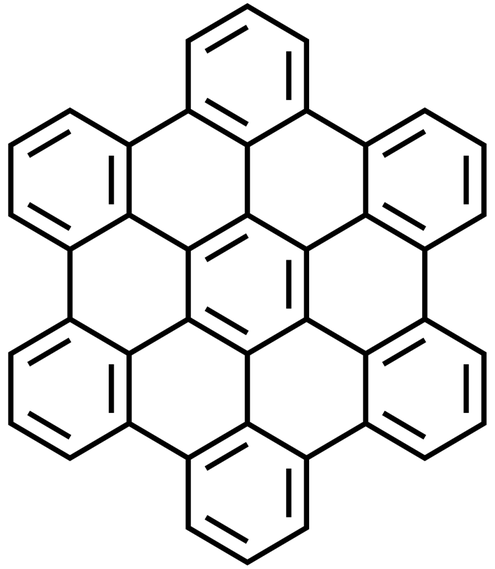
Polycyclic Aromatic Hydrocarbons (PAH)



# The UV 2175Å attenuation bump and PAH emission

Absorb UV photons

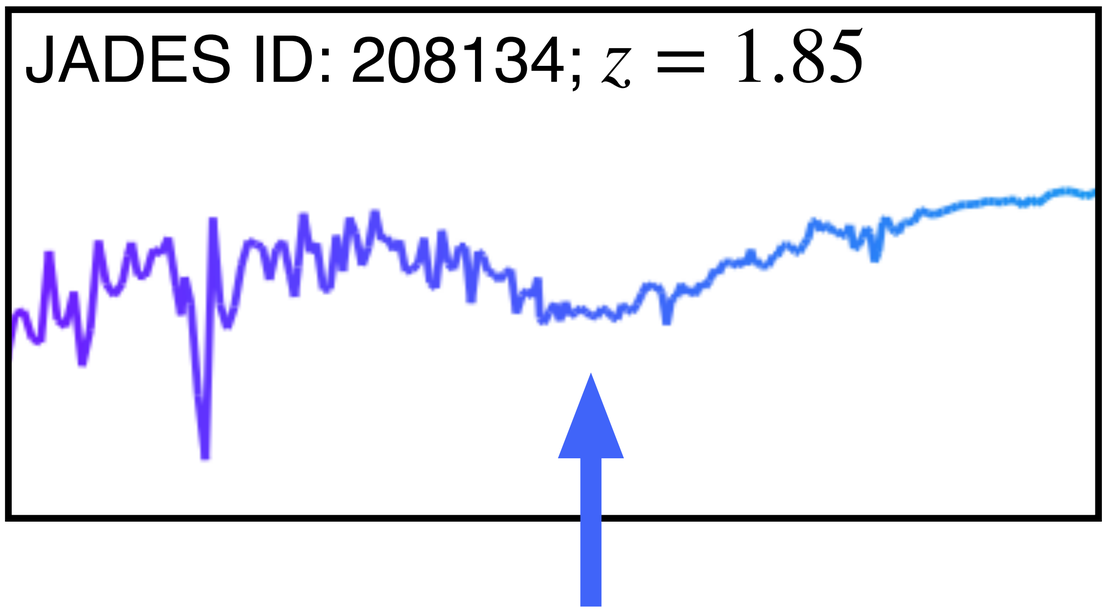


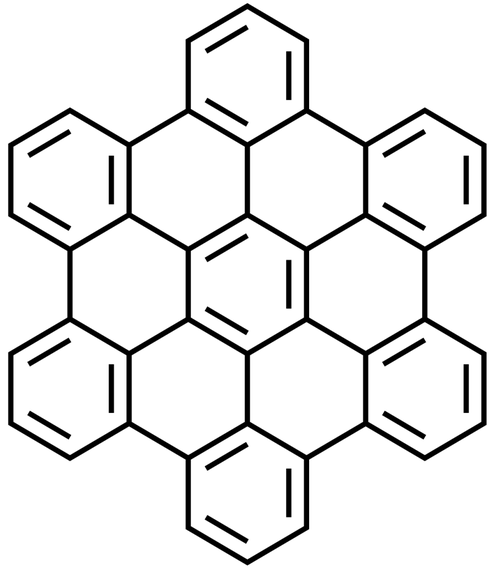



Polycyclic Aromatic Hydrocarbons (PAH)

# The UV 2175Å attenuation bump and PAH emission

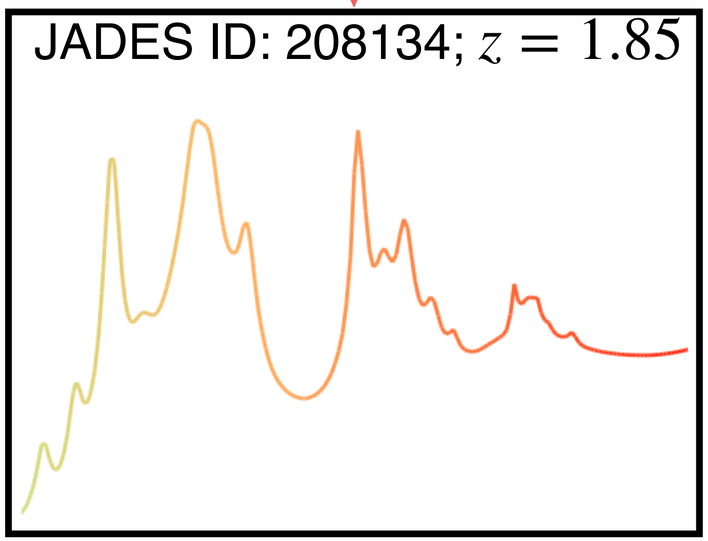
Absorb UV photons



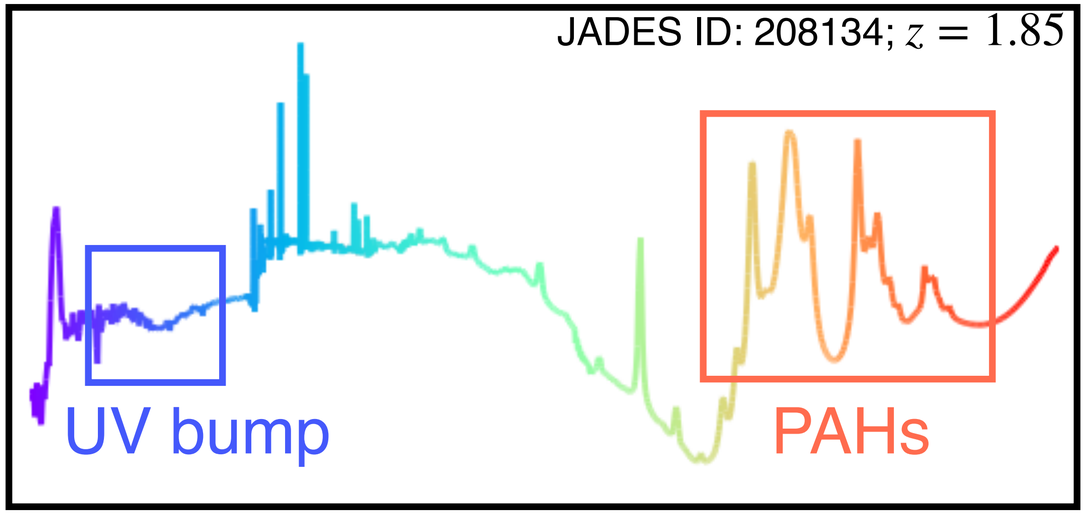
Polycyclic Aromatic Hydrocarbons (PAH)

Re-emit in the IR



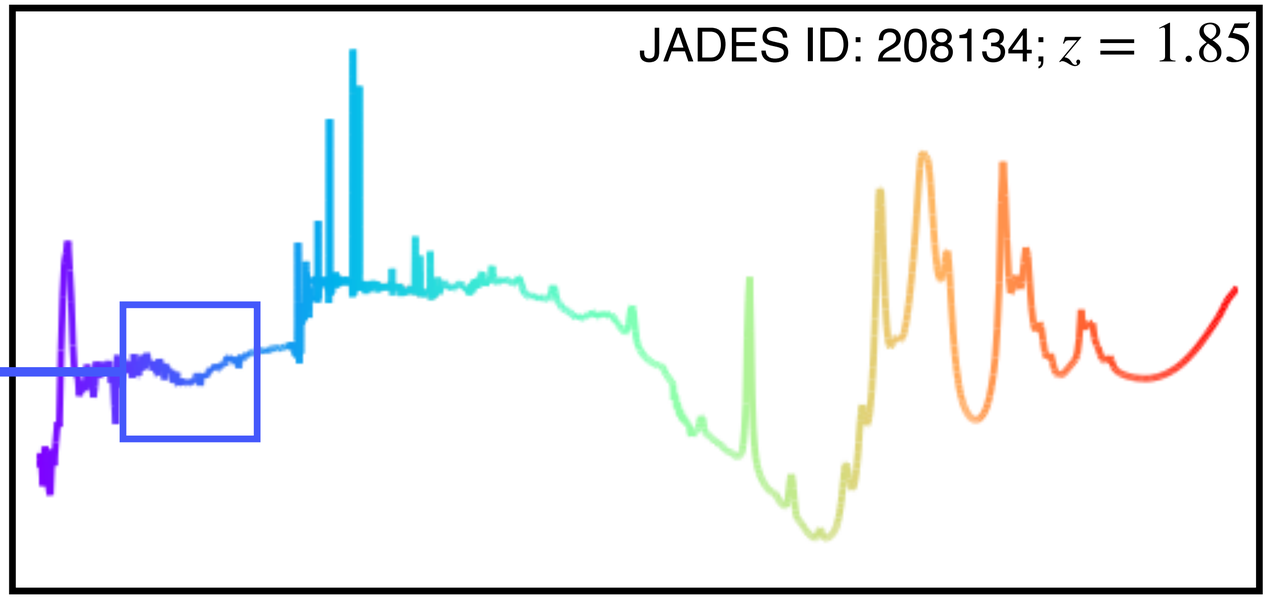
# Objectives

- Characterize the relationship between the UV 2175$\mathring{\text{A}}$ bump and PAH emission at cosmic noon
- Investigate how gas-phase metallicity (based on strong emission line measurements) affects both of these properties
- Examine how these properties relate to other galaxy parameters



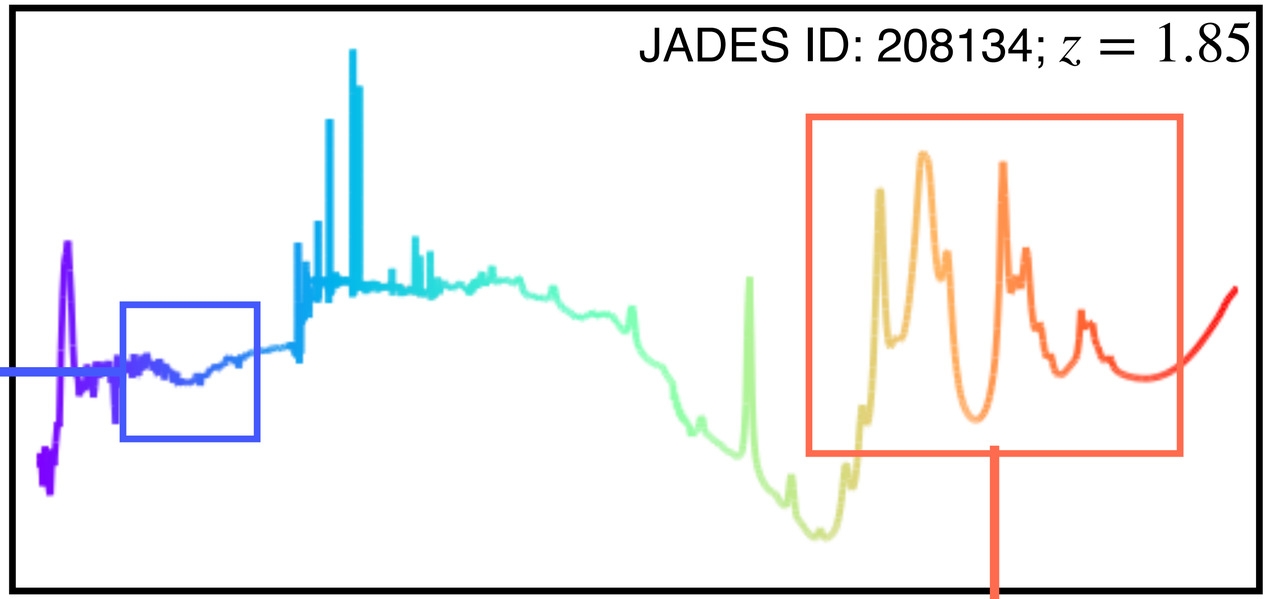
# Sample

- MUSE *Hubble* Ultra Deep Field (HUDF) Survey (Bacon+17, Inami+17)
- 120 galaxies
- $1.5 < z < 2.7$



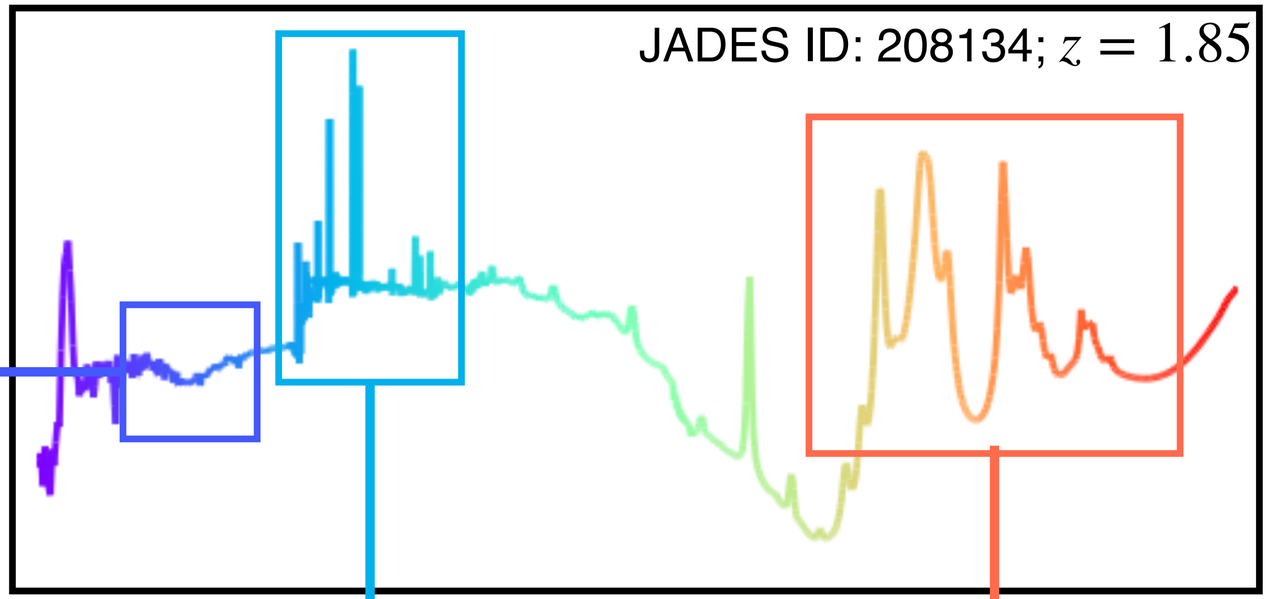
# Sample

- MUSE *Hubble* Ultra Deep Field (HUDF) Survey (Bacon+17, Inami+17)
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- JWST/MIRI data covering PAHs
- 120 galaxies → 49 galaxies

# Sample

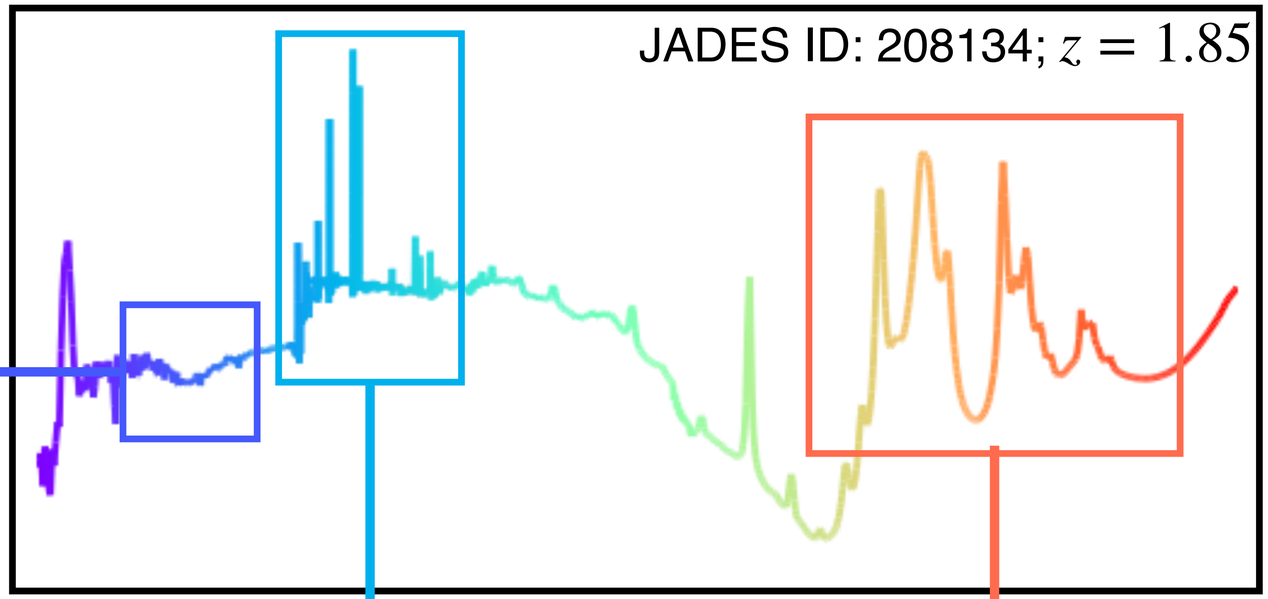



- MUSE *Hubble* Ultra Deep Field (HUDF) Survey (Bacon+17, Inami+17)
- 120 galaxies
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- Keck/MOSFIRE + JWST/NIRSpec emission line fluxes
- 49 galaxies → 19 galaxies

- JWST/MIRI data covering PAHs
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# Sample




- MUSE *Hubble* Ultra Deep Field (HUDF) Survey (Bacon+17, Inami+17)
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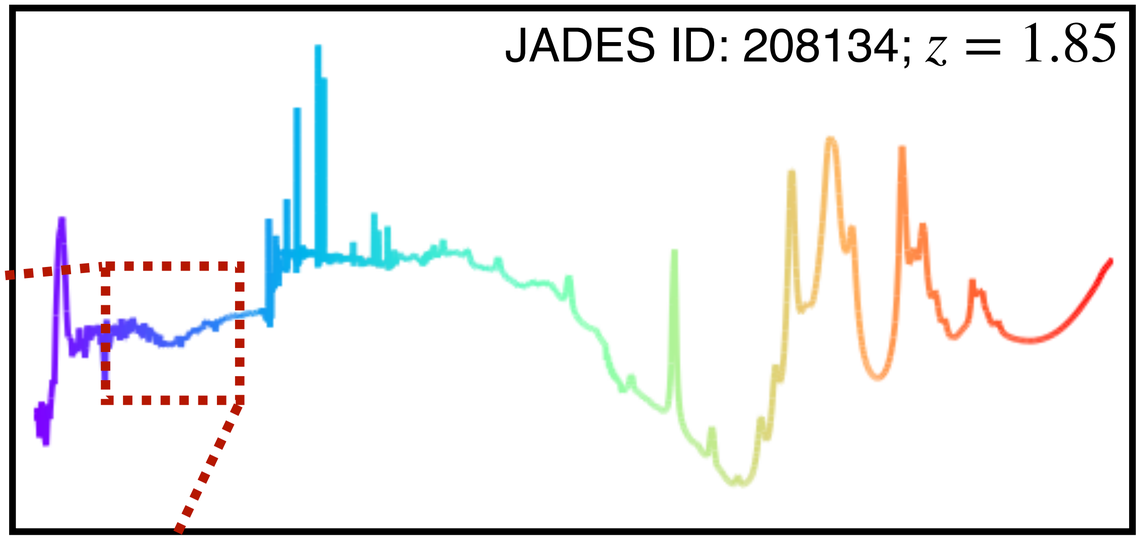
- JWST/MIRI data covering PAHs
- 120 galaxies → 49 galaxies

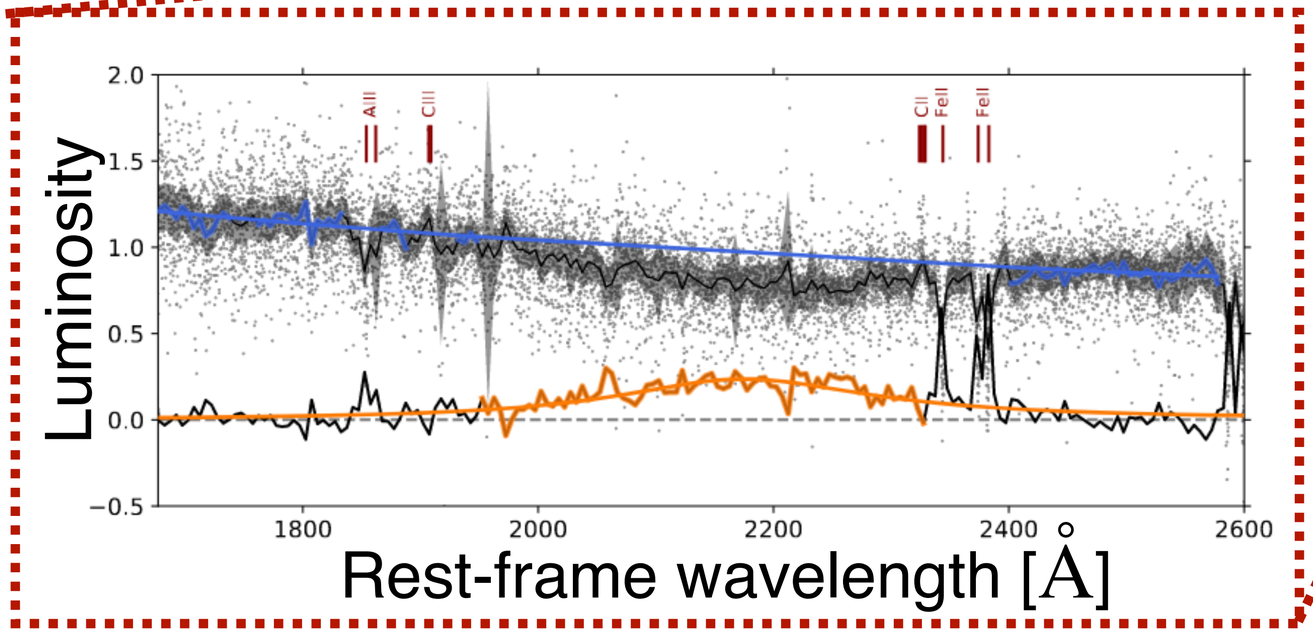
Two samples:

- Final sample with UV bump + PAHs → 49 galaxies
- Subsample with metallicity measurements → 19 galaxies

# Data and methods

- UV bump: VLT/ MUSE data (Bacon+17, Inami+17)

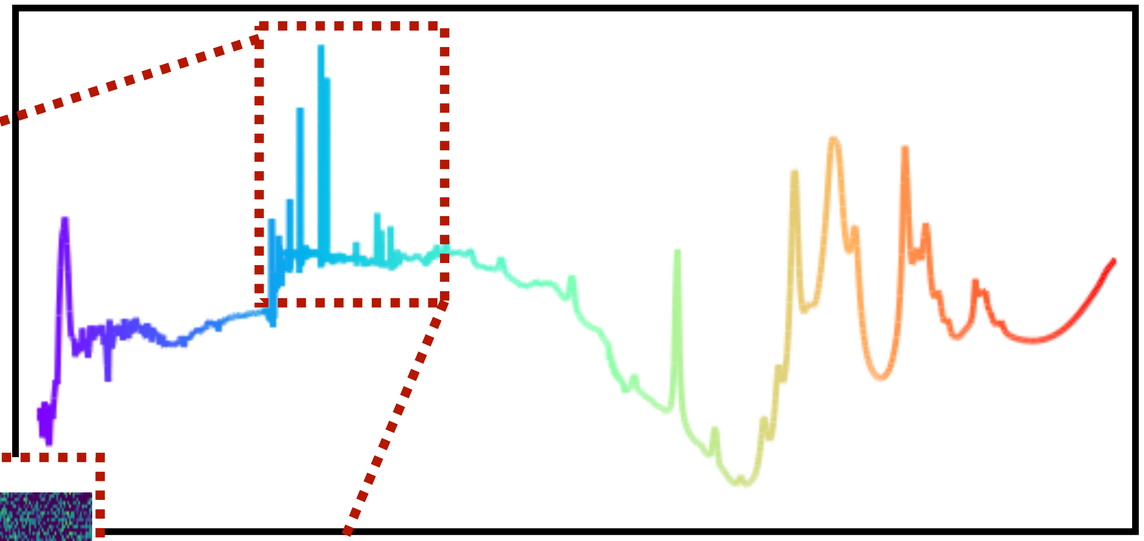


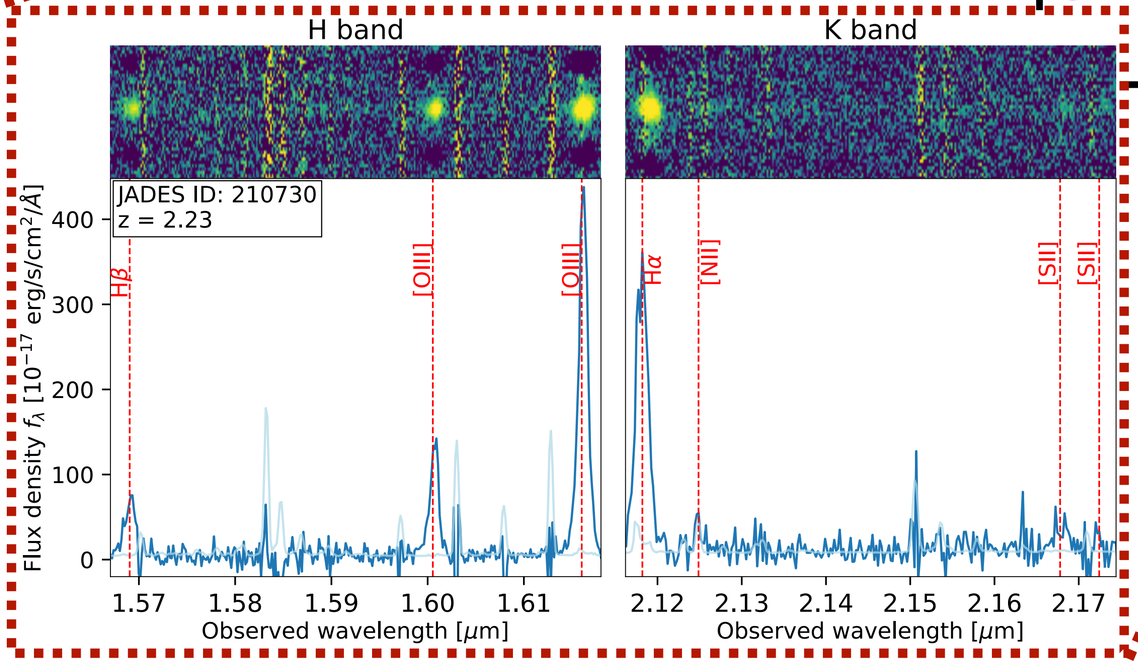




Shivaei+22

# Data and methods

- UV bump: VLT/ MUSE data (Bacon+17, Inami+17)
- Gas-phase metallicities: Keck/MOSFIRE observations (observing programs 2022B+2024B, PIs: D. Calzetti and I. Shivaei)

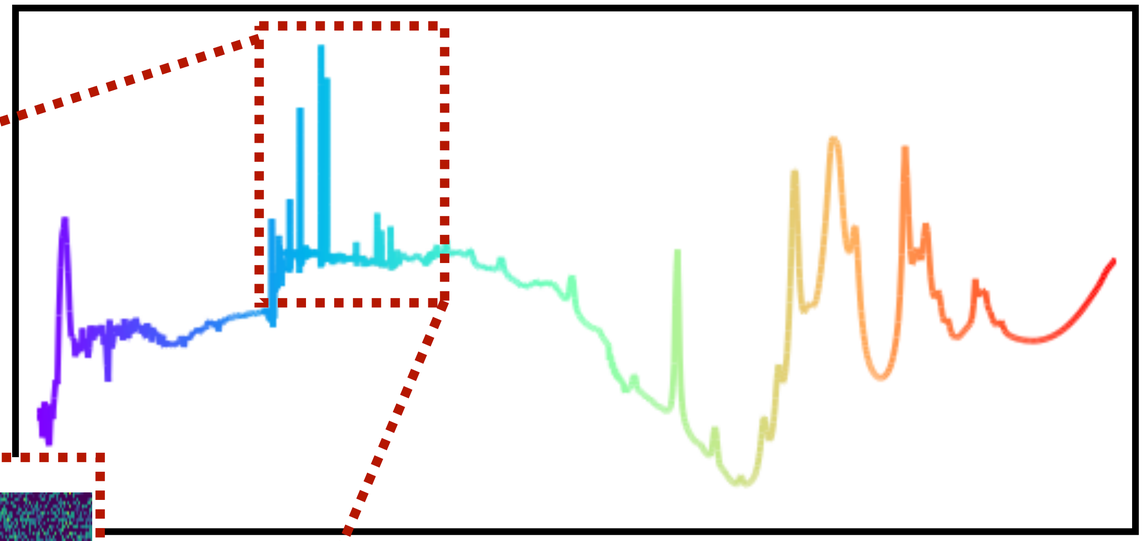


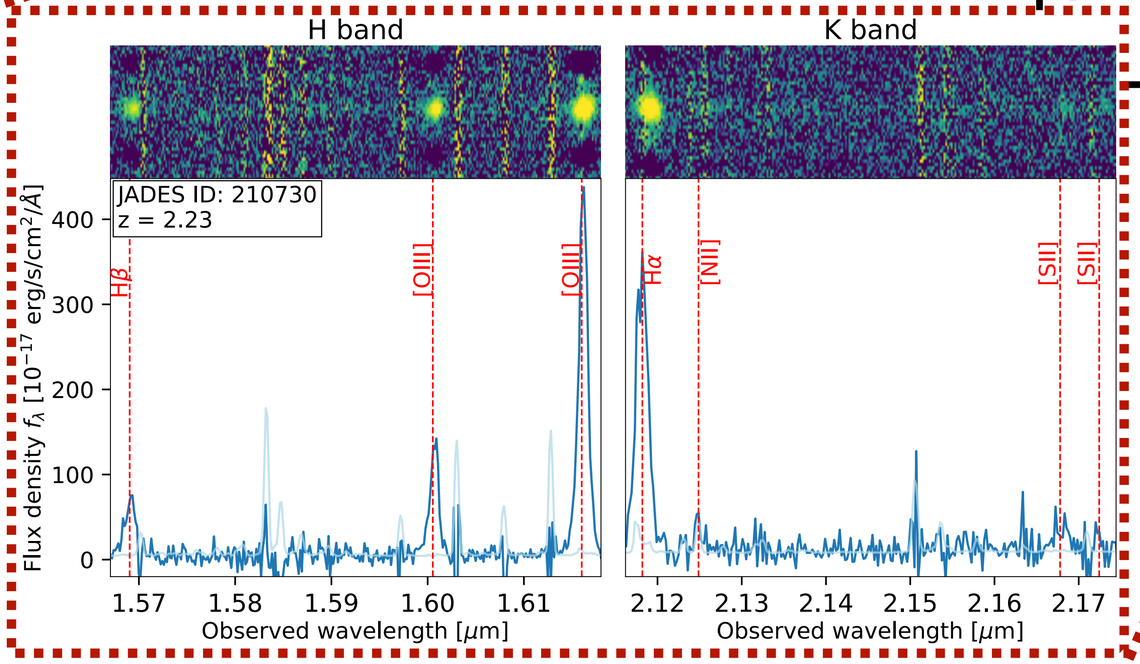



Arriscado *et al.* in prep.

# Data and methods

- UV bump: VLT/ MUSE data (Bacon+17, Inami+17)
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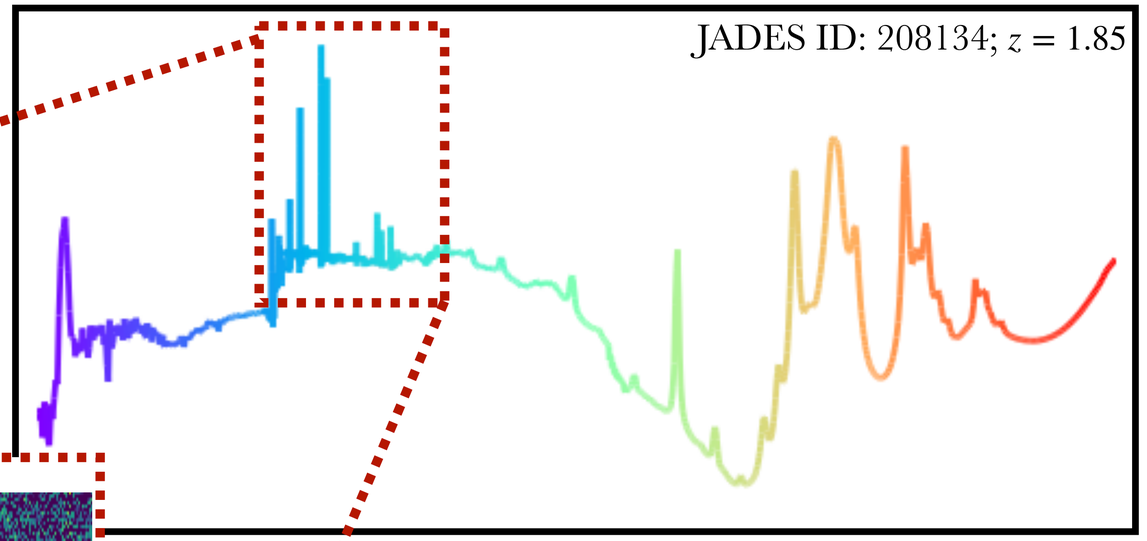


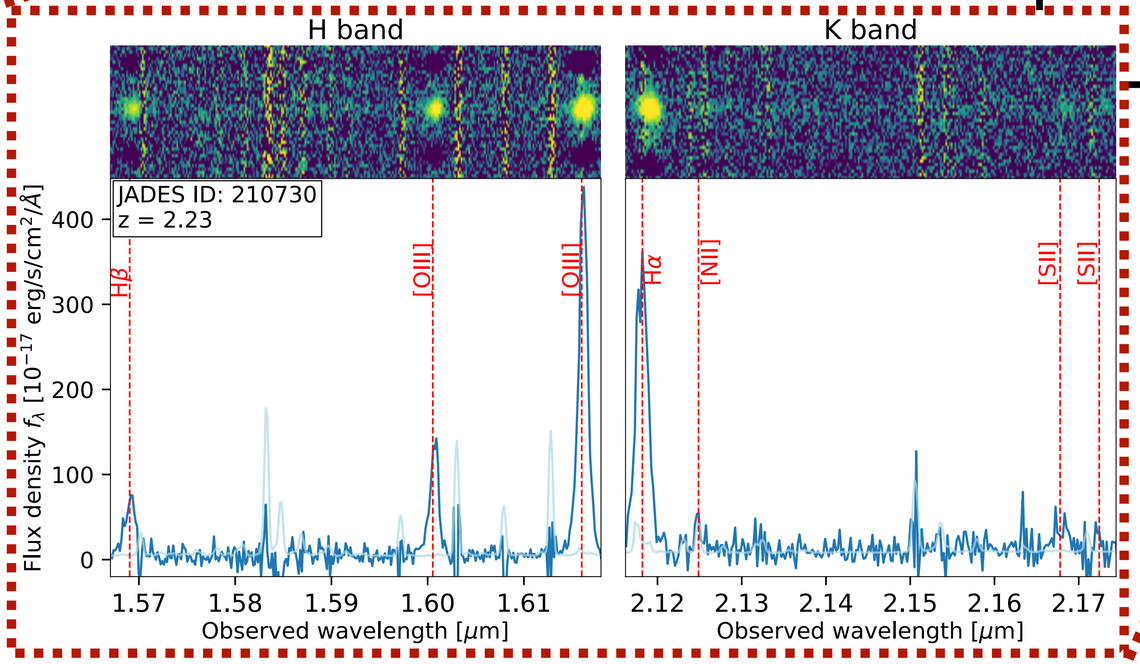
+ data reduction with PypeIt (Prochaska+20)

Arriscado *et al.* in prep.

# Data and methods

- UV bump: VLT/ MUSE data (Bacon+17, Inami+17)
- Gas-phase metallicities: Keck/MOSFIRE observations (observing programs 2022B+2024B, PIs: D. Calzetti and I. Shivaei)




+ Flux measurements from JADES (Scholtz+25) and SMILES (Zhu+25)

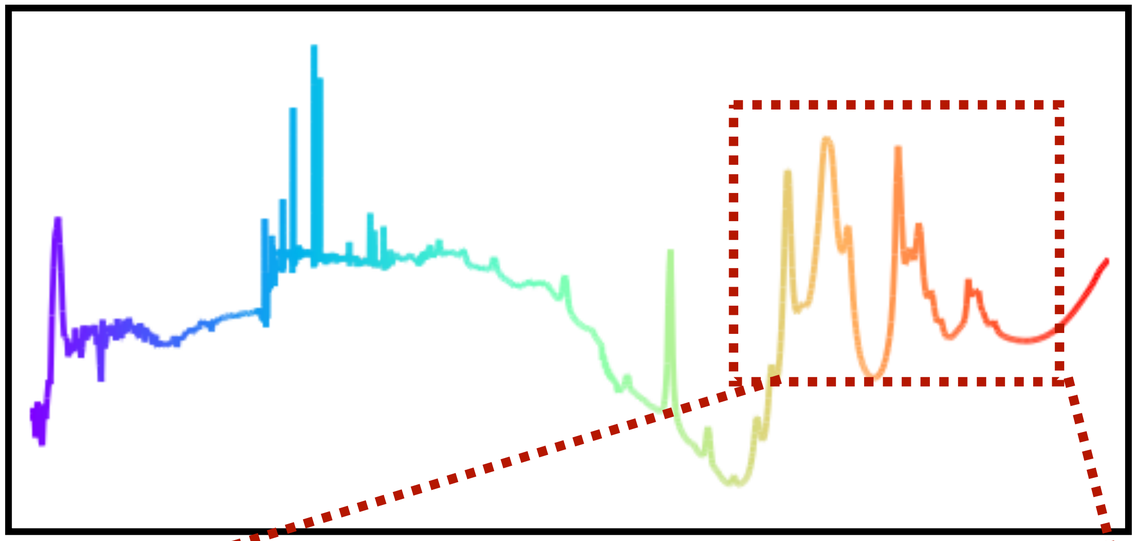
+ Metallicity calibrations from Sanders+25

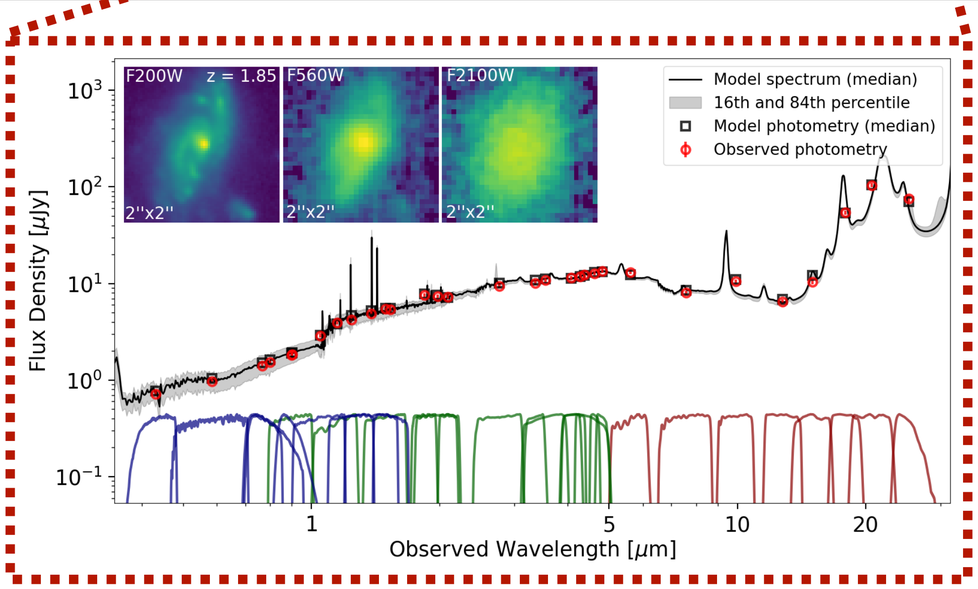
Arriscado *et al.* in prep.

# Data and methods

- UV bump: VLT/ MUSE data (Bacon+17, Inami+17)
- Gas-phase metallicities: Keck/MOSFIRE observations (observing programs 2022B+2024B, PIs: D. Calzetti and I. Shivaei)
- PAH emission: JWST/MIRI (SMILES; Alberts+24) + SED fitting (Prospector)

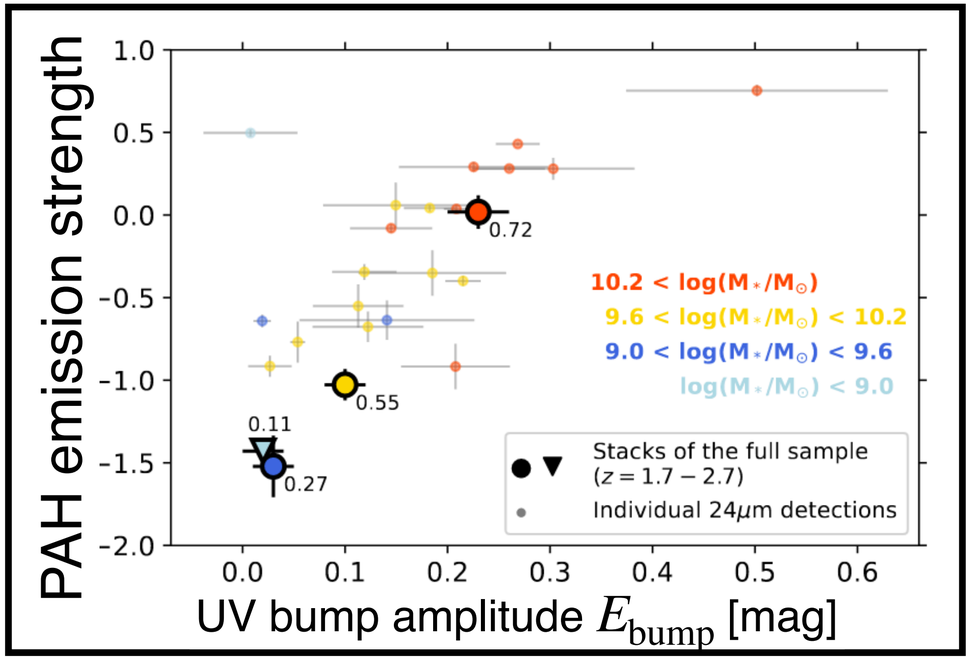
+ JWST/NIRCam (JADES; Eisenstein+23)



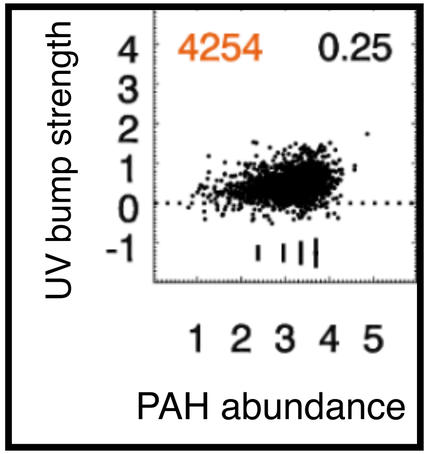



Arriscado *et al.* in prep.

# Results: PAH emission, UV bump, and stellar mass

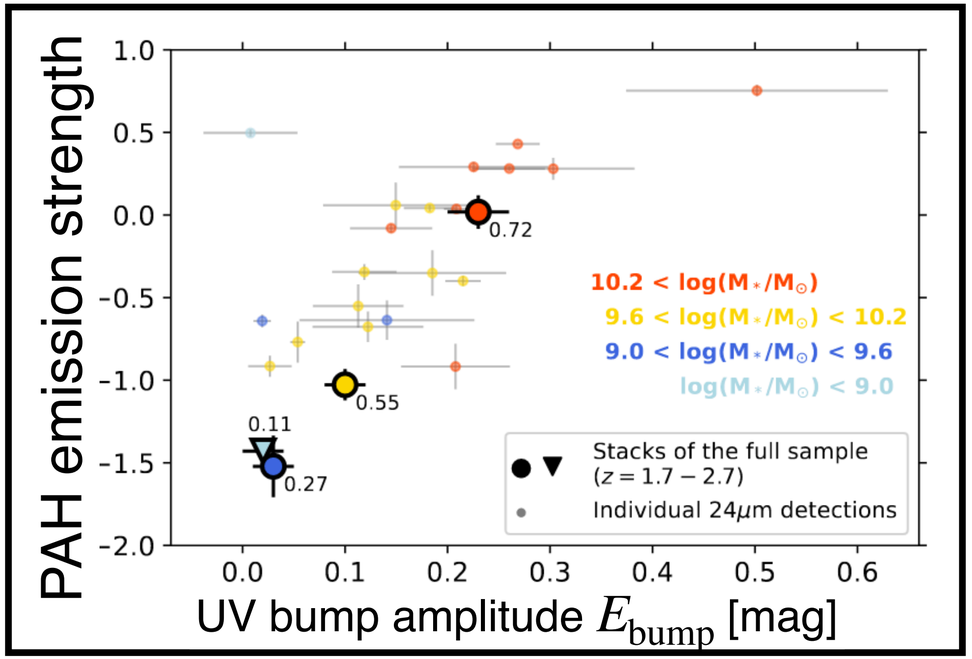



$z \sim 2$ galaxies; Shivaei+22

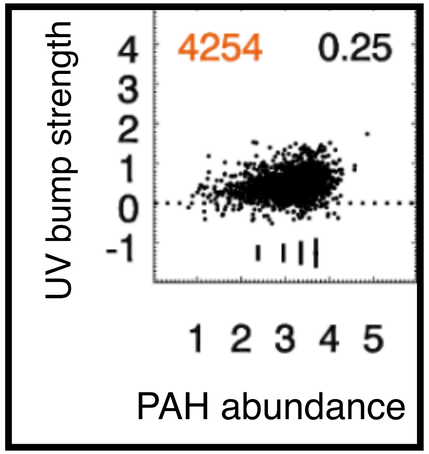



Local galaxies; Battisti+24

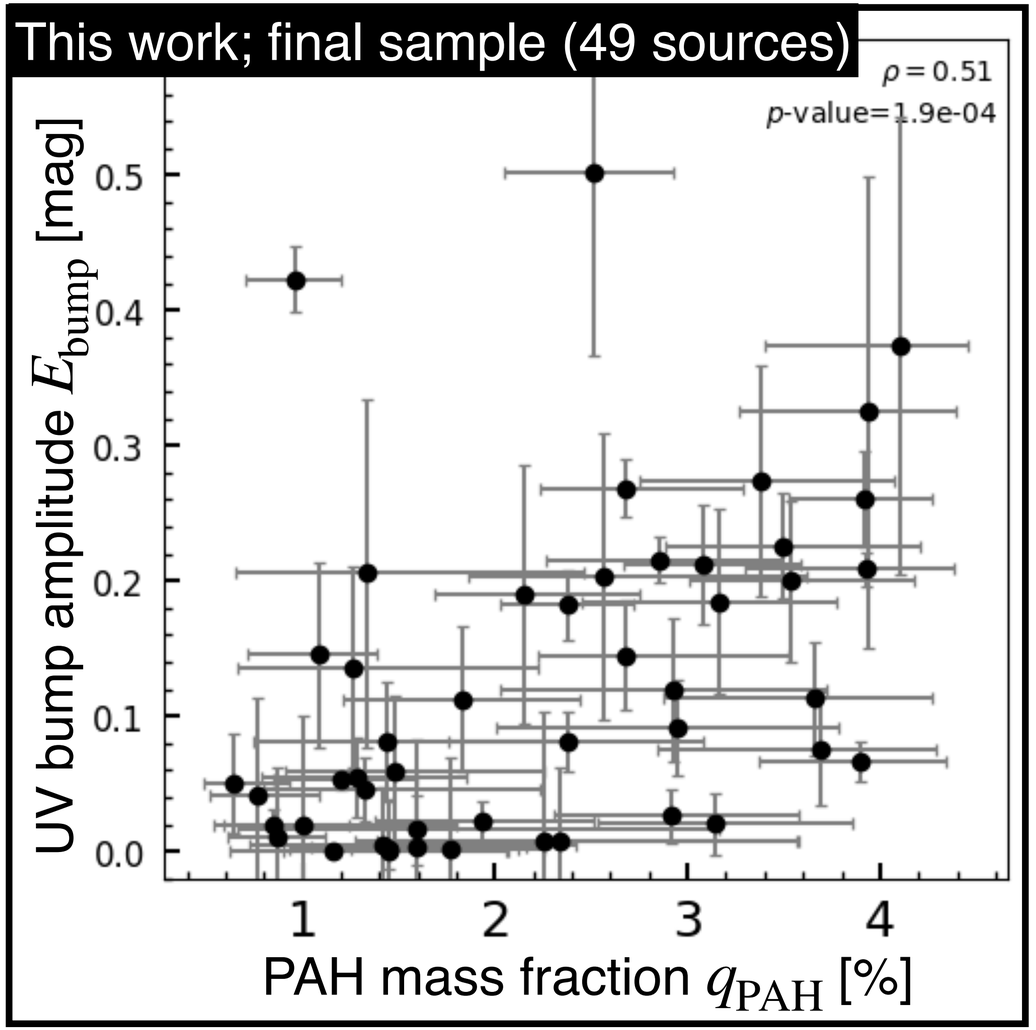
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$z \sim 2$ galaxies; Shivaei+22

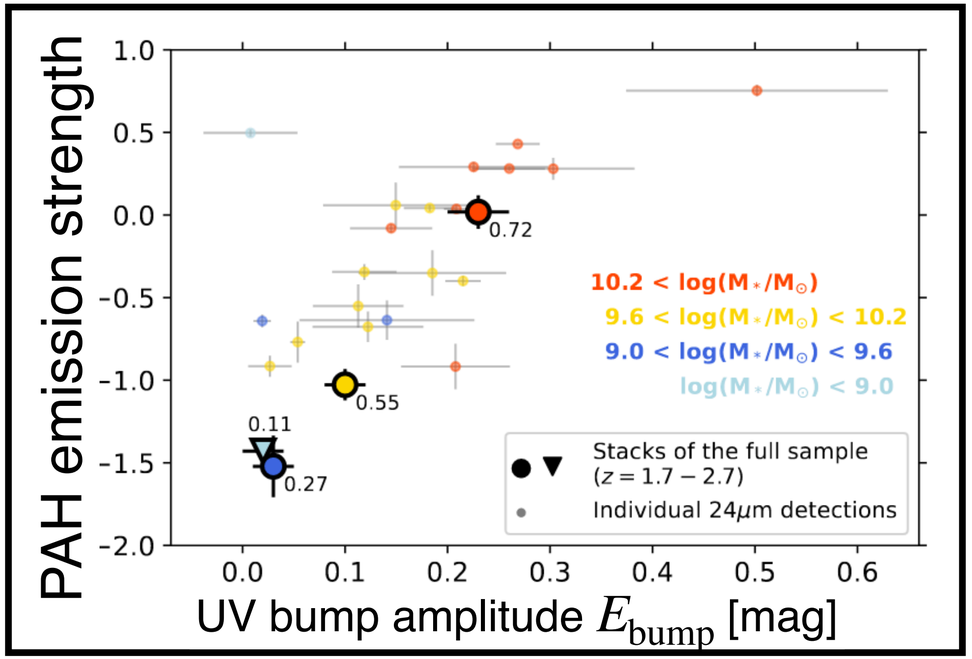



Local galaxies; Battisti+24

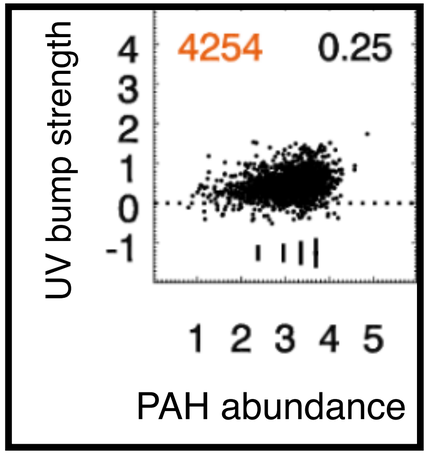



$z \sim 2$ galaxies; Arriscado *et al.* in prep.

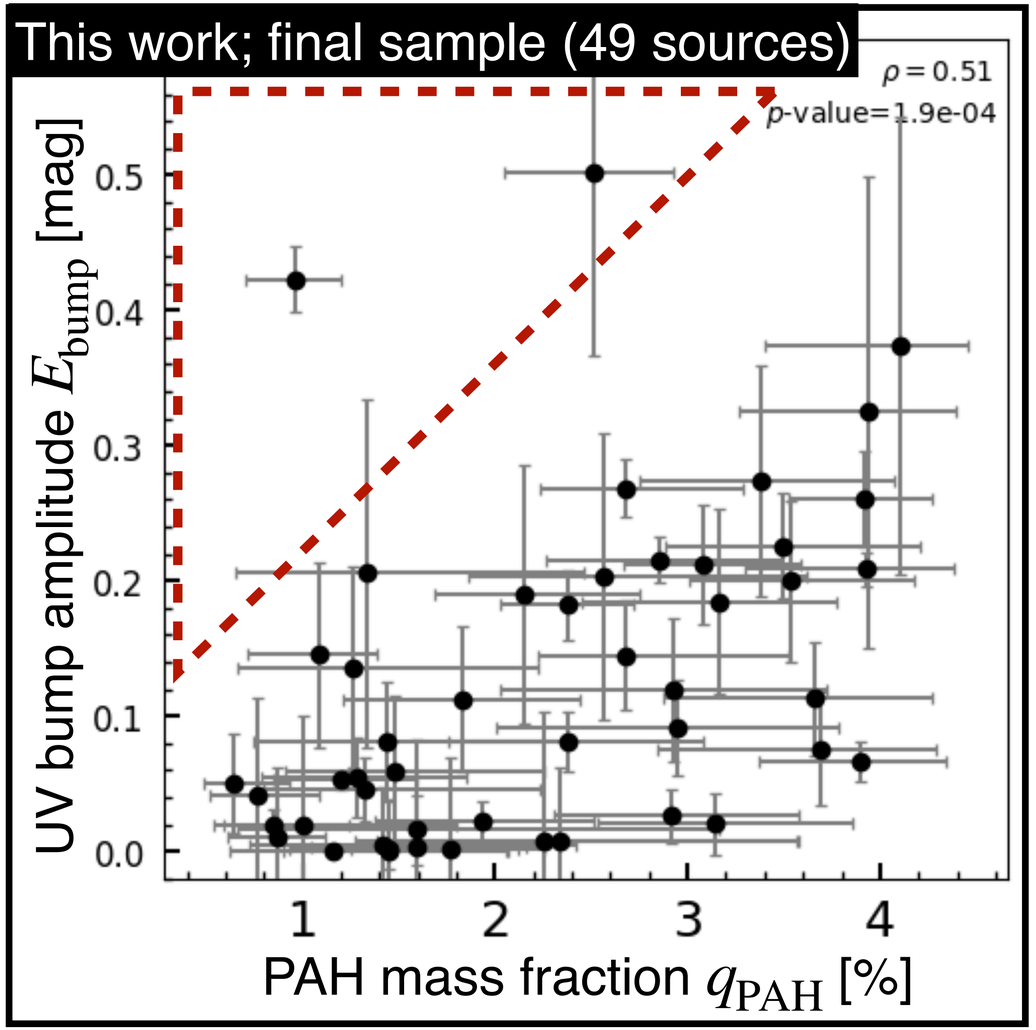
# Results: PAH emission, UV bump, and stellar mass




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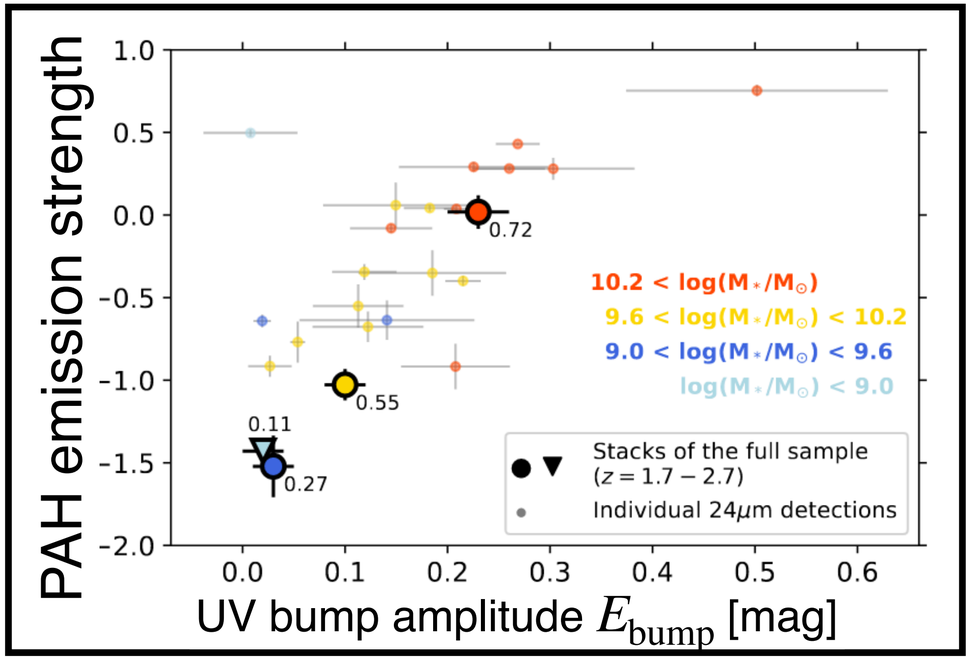


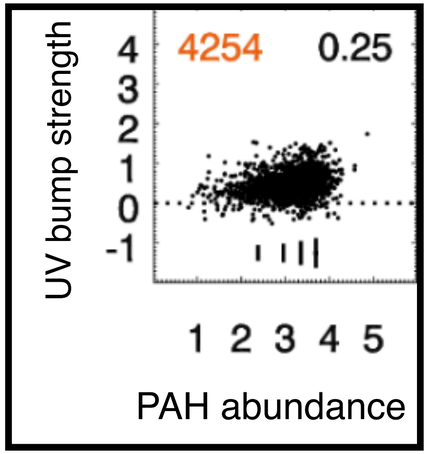

Local galaxies; Battisti+24




$z \sim 2$ galaxies; Arriscado *et al.* in prep.

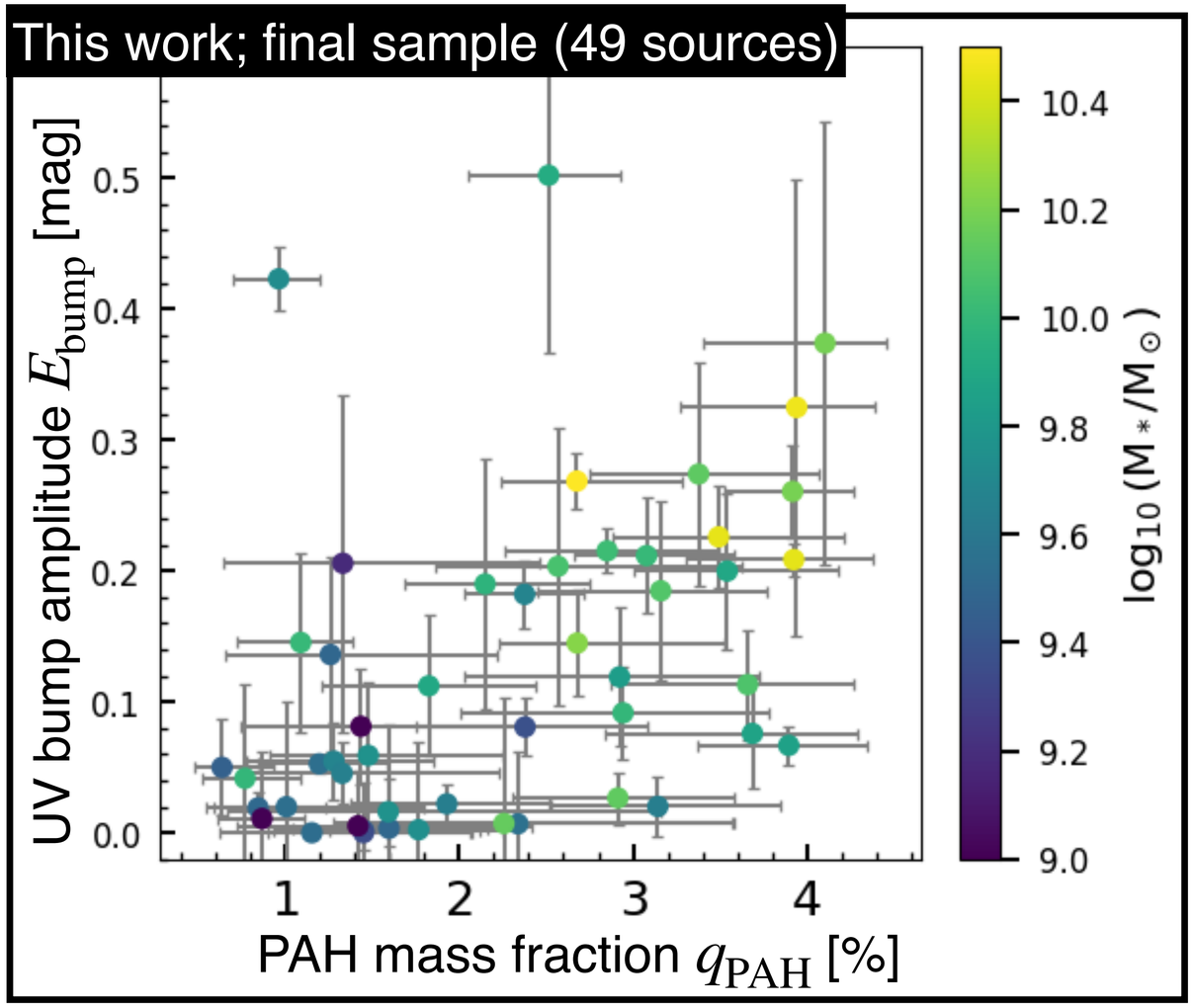
# Results: PAH emission, UV bump, and stellar mass



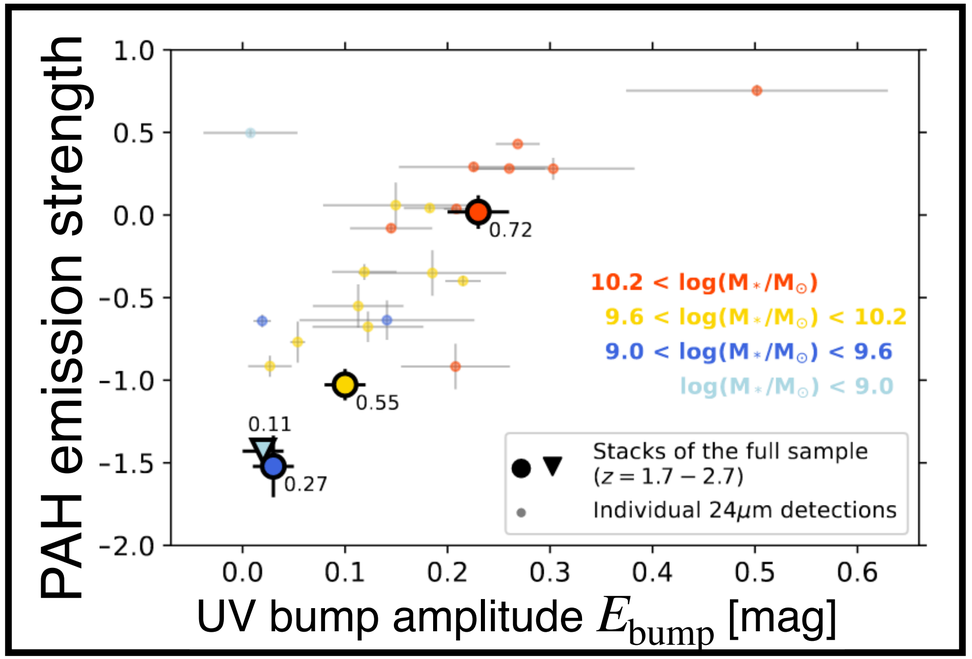

$z \sim 2$ galaxies; Shivaei+22

Local galaxies; Battisti+24

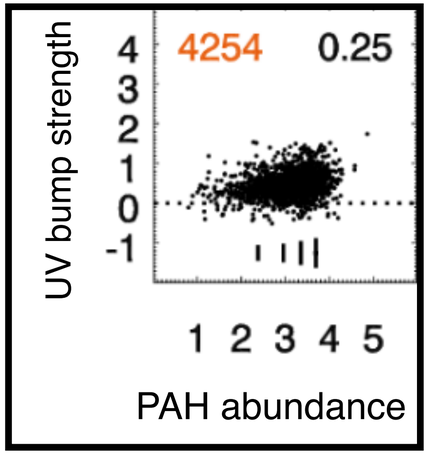



$z \sim 2$ galaxies; Arriscado *et al.* in prep.

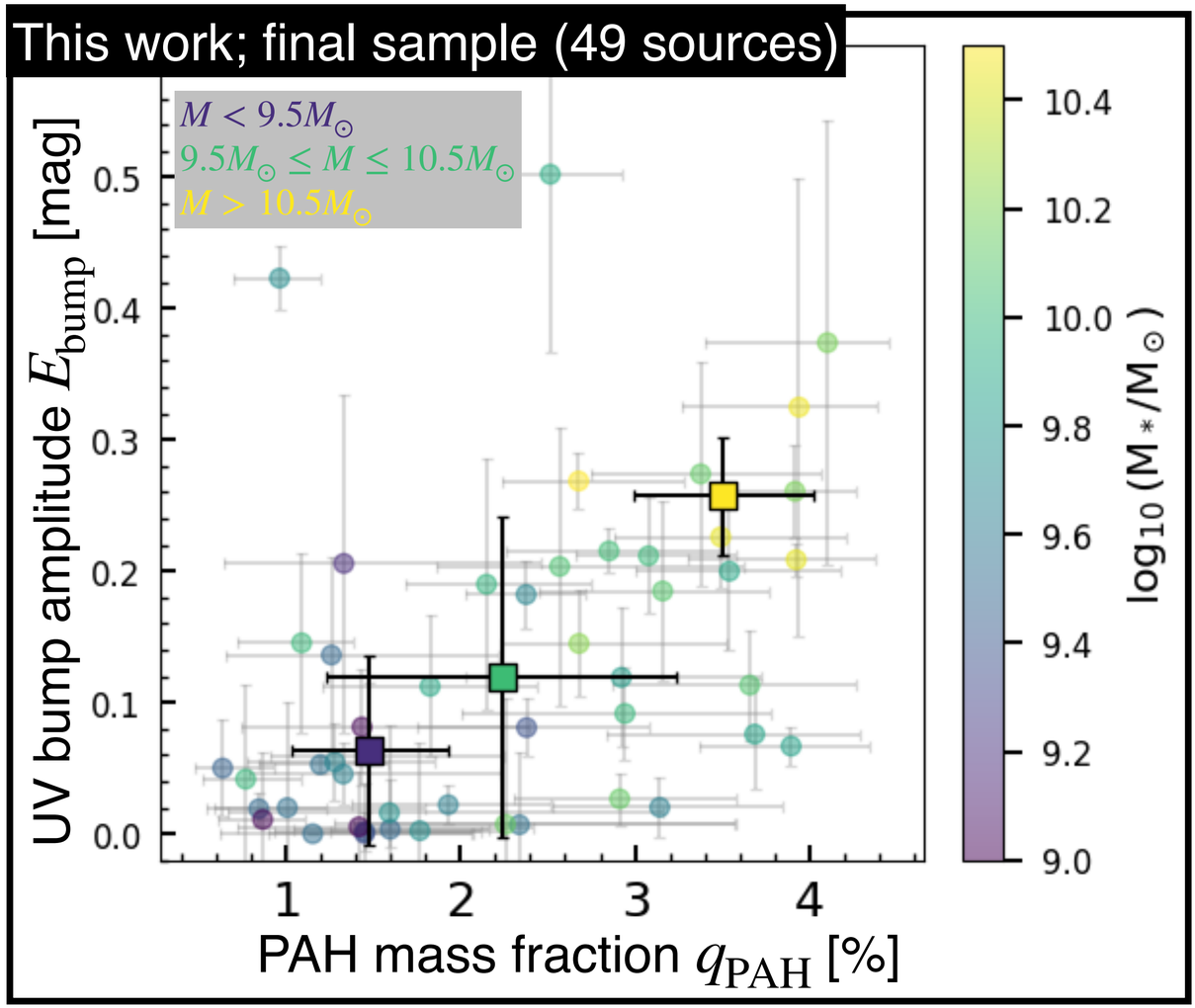
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$z \sim 2$ galaxies; Shivaei+22

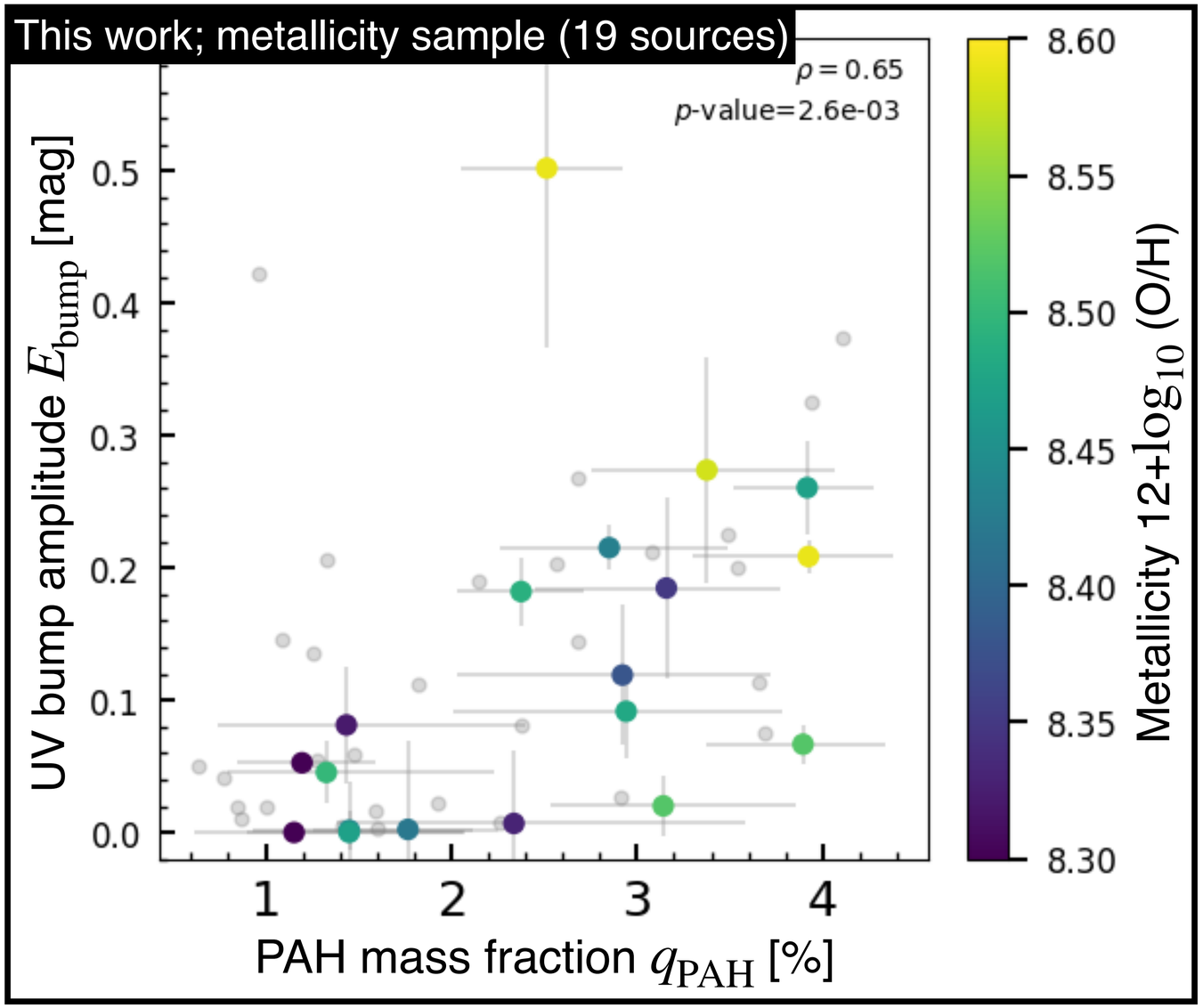



Local galaxies; Battisti+24



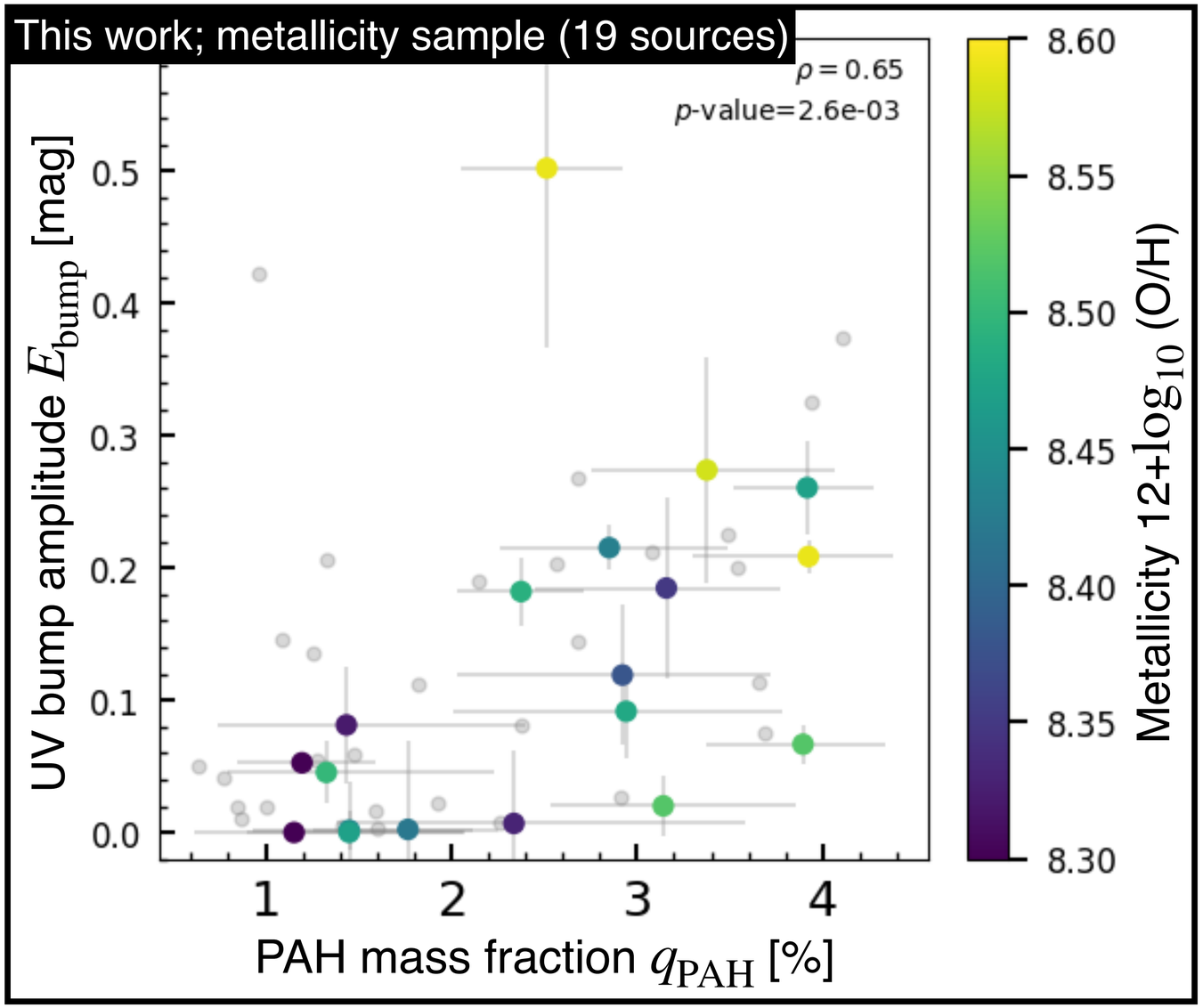

$z \sim 2$ galaxies; Arriscado *et al.* in prep.

# Results: PAH emission, UV bump, and metallicity




$z \sim 2$ galaxies; Arriscado *et al.* in prep.

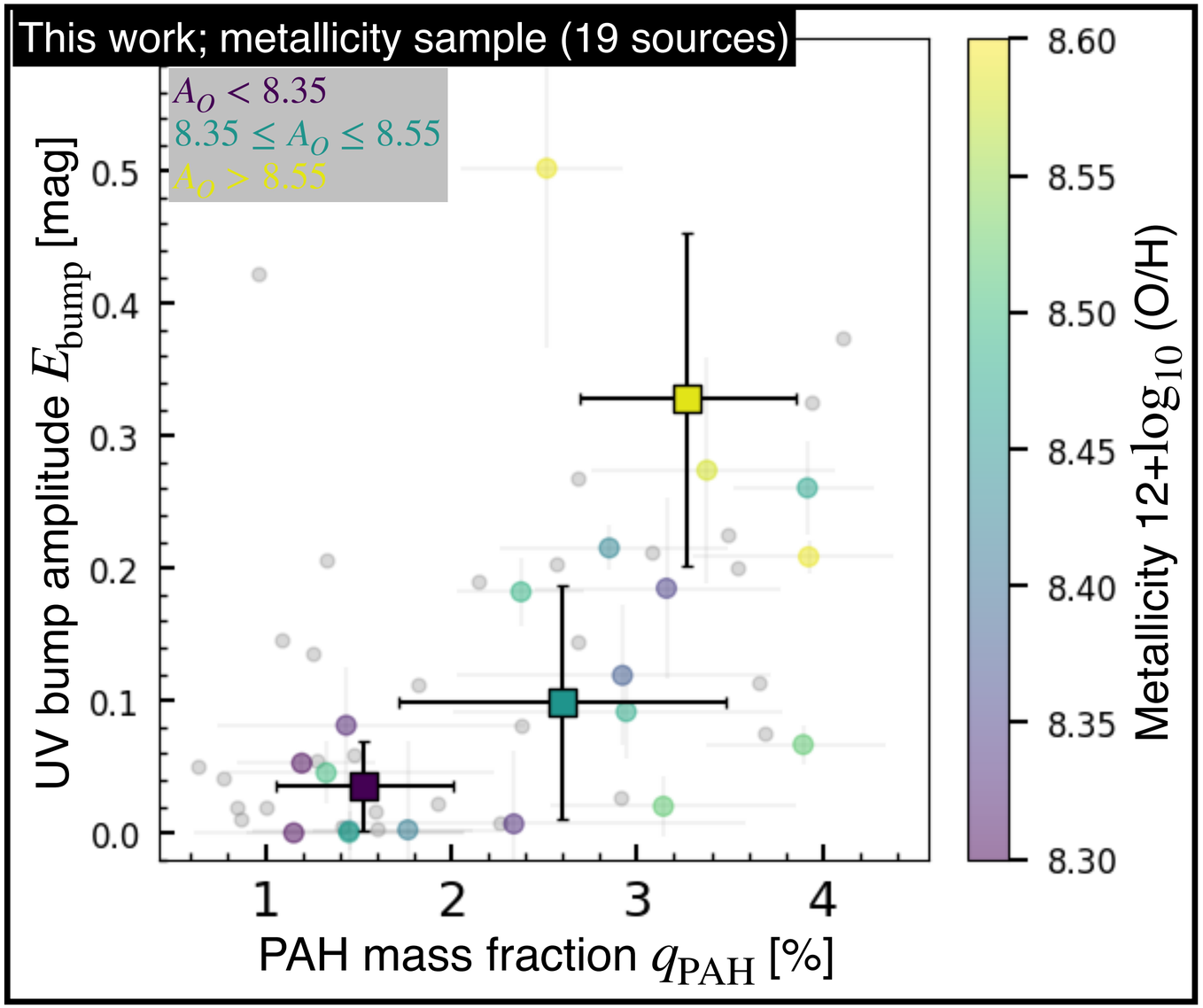
# Results: PAH emission, UV bump, and metallicity




First time: correlation between PAH emission, UV bump attenuation and gas-phase metallicity measurements from strong emission line calibrations

$z \sim 2$ galaxies; Arriscado *et al.* in prep.

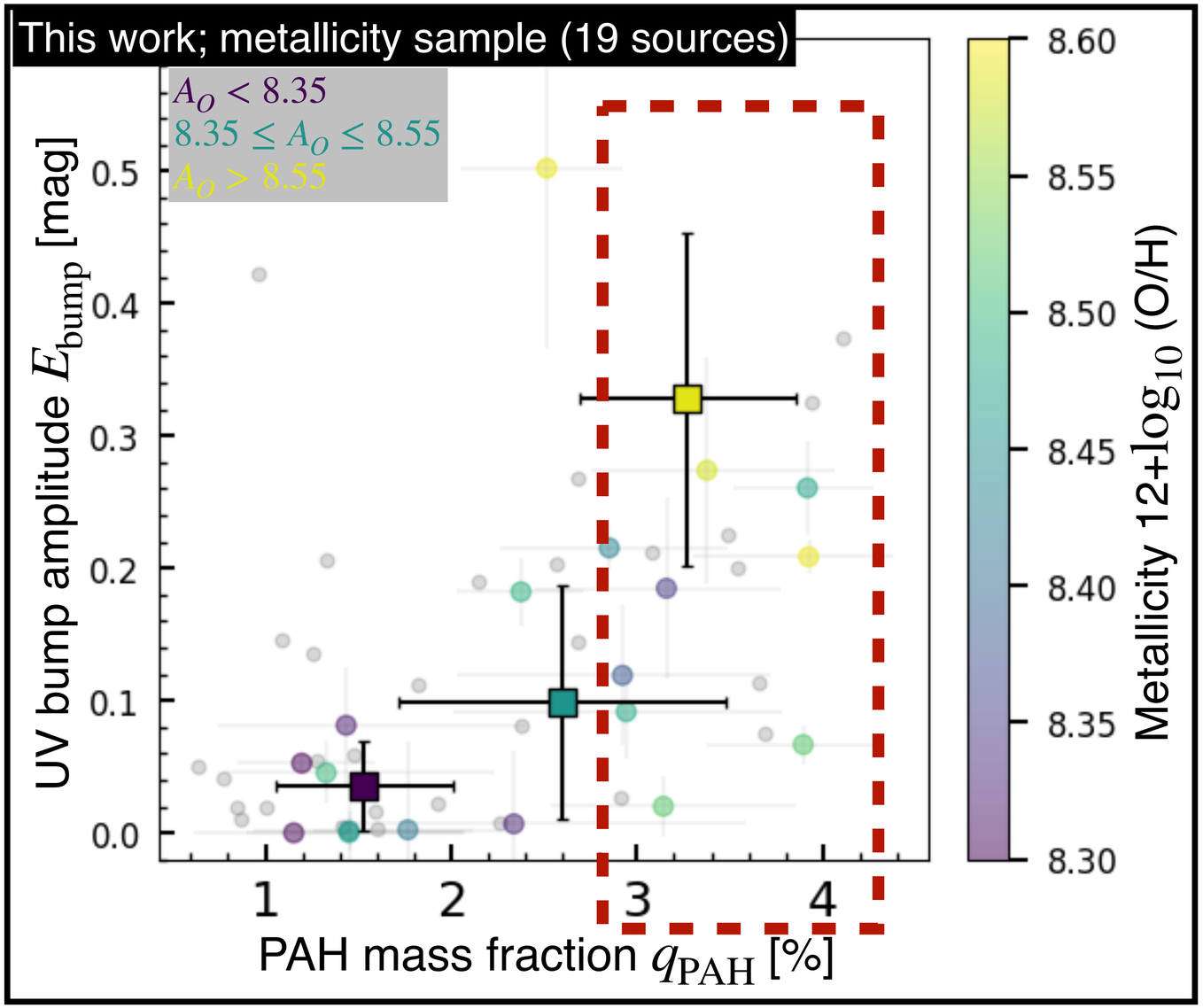
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$z \sim 2$ galaxies; Arriscado *et al.* in prep.

# Results: PAH emission, UV bump, and metallicity

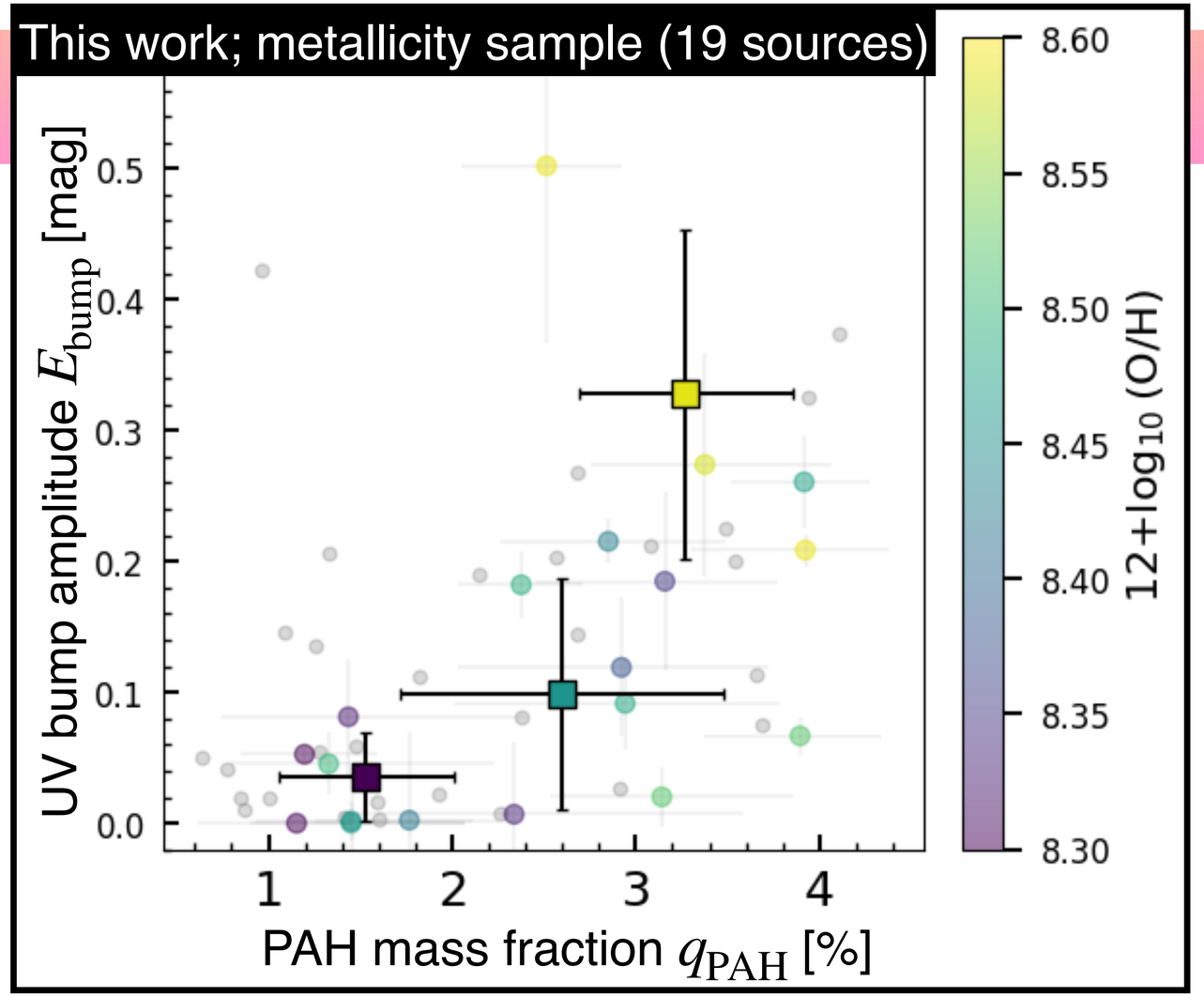



First time: correlation between PAH emission, UV bump attenuation and gas-phase metallicity measurements from strong emission line calibrations

$z \sim 2$ galaxies; Arriscado *et al.* in prep.

# Summary

- We present for the **first time** a study between **PAH emission**, **UV bump attenuation** and **gas-phase metallicity** measurements from strong emission line calibrations at cosmic noon.
- The results support that PAHs are the **main carriers** of the bump, but that there are additional mechanisms at play that we still don't understand.
- Both PAH emission and UV bump strength correlate with metallicity, supporting a scenario where **low-metallicity regions have a lower abundance of PAH molecules**, which results in **low bump strength** (or no bump).




$z \sim 2$ galaxies; Arriscado *et al.* in prep.

This work is supported by ERC grant DistantDust, GA No. 101117541. This work is also supported by the CSIC Program 'Programa JAE (JAE-Pre 2023), and by the grant PID2024-158856NA-I00 funded by Spanish Ministerio de Ciencia e Innovación MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe"